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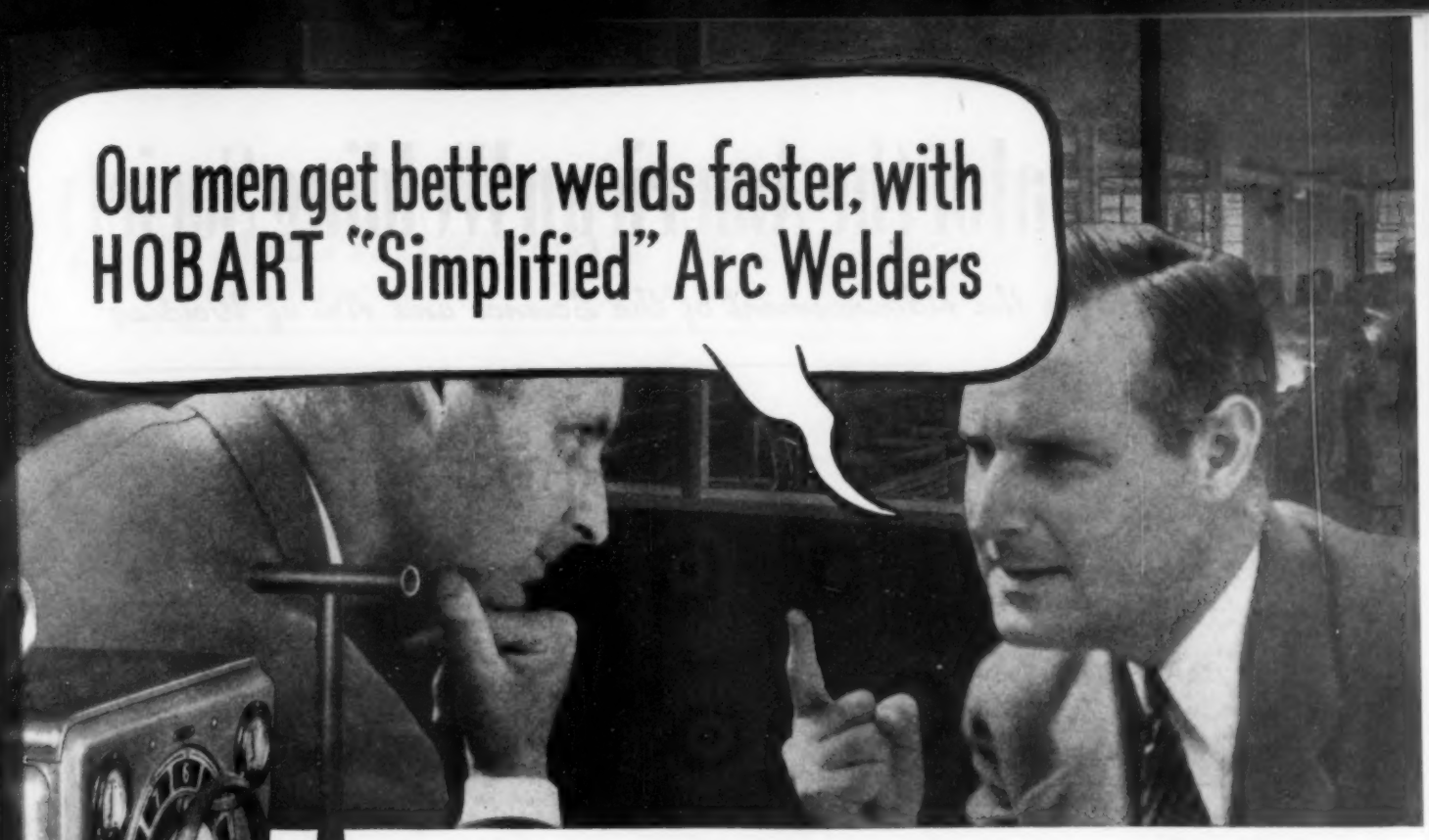

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Welding Expanded Metal Cylinder.
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Stainless Steel Cutting*

By Howard G. Hughey†

Introductory

ALTHOUGH for many years, the production of steel and the oxygen cutting process have been closely associated, until recently stainless steel has been excluded for all practical purposes from this association. In the 1920's, stainless steel began to assume commercial importance and with increasing production, attention was directed toward practices which could bring about lowered costs. Of prominence was a desire to utilize oxygen more effectively for the severence of sections.

Such early attempts that were made in this direction centered about the common knowledge available from the use of oxygen cutting in other fields and resulted in a number of interesting techniques. Although of minor commercial importance, these did provide information of sufficient basic interest to enable a better understanding of present-day methods. These earlier methods are discussed briefly.

Scope of Field

The problem has always centered about the most popular analyses which account for the major output. In this category are the 18–8 or closely associated analysis and the straight chromium analysis, particularly in the range of 12 to 18% chromium. Further reference to general classes when stating 18–8 imply such close analysis as 17–7, etc., and when stating straight chromium, imply ranges of from 12 to 18%.

An excellent reference to the extent of the field is found in *Iron Age*, Jan. 1946 issue. In 1930, the ingot production was about 55,000 tons; by 1940 it had increased to about 265,000 tons; and by 1945 it had reached 550,000 tons. Of the 1945 tonnage, 60% fell in the 18–8 group; 28% in the straight chromium group; while the remaining 12% represented diverse analysis such as 25–12; chromium alone and above 18%; and miscellaneous combinations. In addition to the ingot production for 1945, there was also reported some 18,000 tons of castings of which 23% was 18–8; 24% was 25–12; and 4% was straight chromium. The balance was largely special purpose analyses such as 35–15 and 60–12. Actually, these figures disclose that 85% of the 1945 stainless steel production was of 18–8 and straight chromium category.

* Presented at the Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., week of Nov. 17, 1946.

† Research Engineer, Apparatus Research Dept., Air Reduction Sales Co., New York City.

Oxidation Analysis

Although the outstanding property of stainless steels is their resistance to oxidation, the very problem under consideration embodies a rapid, controlled method of oxidation. The earliest attempts utilized conventional cutting equipment which was available for carbon steel cutting. Invariably the reaction was ineffective and left only a rough film of impenetrable oxide where the action was attempted. It was realized that the oxide, having a melting point of 3600° F. required a greater temperature for good fluidity and that without this fluidity at the start of the cut, the oxygen stream would not penetrate, but would be deflected.

A further understanding of the cutting process discloses that heat for its reaction comes not only from preheat, but to a large degree from the combustion of the iron and oxygen. The preheat is particularly applicable to the top portion of cut where the iron and oxygen begin to combine, but have not yet generated much heat. Further down in the cut, sufficient heat is generated from the iron-oxygen reaction to provide continuity. However, in the kerf, the envelope of burning secondary preheat products is essential to prevent chilling of the dispersed slag by cold air. Obviously with material such as stainless steel which develops oxides or other impediments requiring high temperatures, the heat demand becomes large.

It must be further realized that as the alloy percentage increases for any thickness, the iron content decreases and thereby reduces the potential heat output. For 18–8 stainless steel, only 74% of iron exists compared to

Elements	Melting Point		Carbide	Melting Point		Oxides	Melting Point	
	Deg.F	Deg.C		Deg.F	Deg.C		Deg.F	Deg.C
Iron	2795	1535	Iron	3338	1837	Iron(Fe_2O_3)	2849	1565
Chromium	2939	1615	Chromium	3434	1890	Iron(FeO)	2588	1420
Nickel	2645	1452				Fe_3O_4	2800	1538
Molybdenum	4748	2620	Molybdenum	4648	2570	Chromic(Cr_2O_3)	3614	1990
Columbium	3542	1950	Columbium					
Titanium	3772	1800	Titanium	5756	3180			
Zirconium	3452	1900	Zirconium	9212	5100			

STAINLESS STEEL RANGE 2550-2730° F

Fig. 1—Materials Found in Stainless Steels

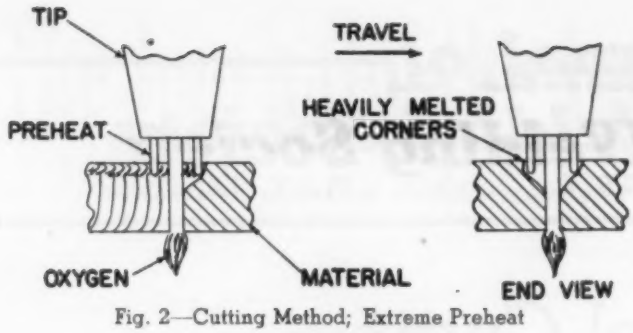

Fig. 2—Cutting Method; Extreme Preheat

carbon steel of over 99% iron content. This factor makes the problem only more difficult.

Prime consideration has been given to chromium oxide as the major impediment since it is likely to occur in quantity. It is the major product after reaction occurs. However, before the oxidation stage is reached, analysis of the metal brings out the presence of pure metals such as chromium, or other alloys and carbides such as chromium carbide. All of these have melting points ranging upward from about that of iron and are listed in Fig. 1. Of course, the carbides in particular may not be present in quantity and are presumed well dispersed as also is the case for all alloying elements. However, any accumulation or segregation may place a heavy demand upon the heat input and may even cause cessation of reaction. For example, molybdenum as a pure metal or as a carbide has a melting point over 4600° F. and is to be compared to iron at about 2800° F. or chromium oxide at about 3600° F. Other commonly used alloys present even more severe conditions.

Early Approaches

Early studies which recognized the foregoing problems resulted in attempts to provide added heat inputs. The first approach was the use of conventional equipment with increased preheat. This is portrayed in Fig. 2. A badly melted edge and early discontinuity of cut resulted. We realize now that the heat was of necessity outside of the useful zone and that molten metal or the formation of solidified oxides could cause deflection of the oxygen stream. In cases where straight chromium up to 8 or 10% existed, some results were realized but this did not meet the requirements of the broad field.

As an offshoot from the foregoing, a technique was applied which imparted motion and a washing action as portrayed in Fig. 3. In this method the time element aided in building up temperature requirements within the work piece. While some successful results were reported, the economics, the difficulties of use and the general unrealiability precluded extensive use.

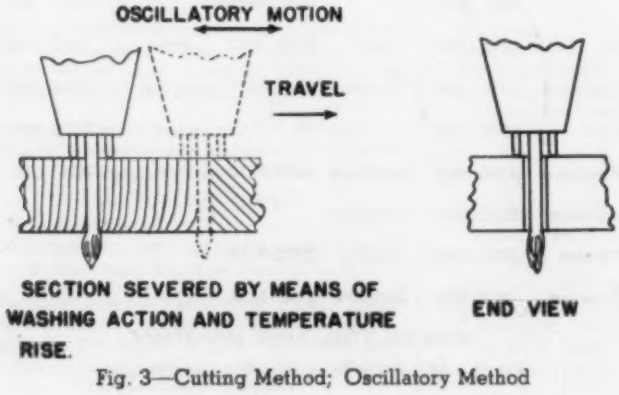

Fig. 3—Cutting Method; Oscillatory Method

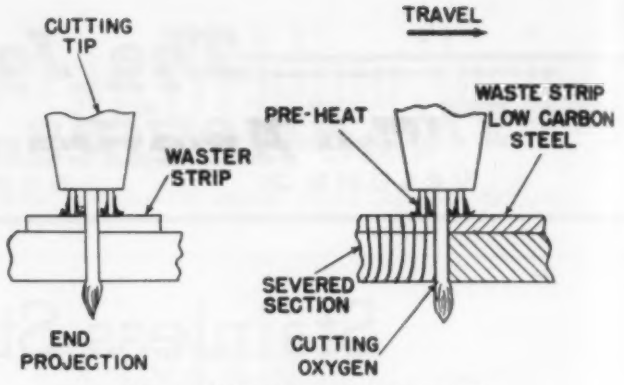

Fig. 4—Cutting Method; Waster Strip

Turning from conventional apparatus as a self-sufficient heat supply, attempts were made to augment the heat input from other sources. The use of an auxiliary iron-oxygen reaction to provide the necessary thermal requirements was given extensive consideration. This appeared particularly attractive if the thermal conditions could be established prior to, adjacent to and continuous with the cutting action. The application of a waster strip, Fig. 4, is portrayed. This strip, of ordinary low carbon steel, permitted initiation of the reaction which, after establishment, continued into the stainless steel. In particular, on relatively thin section, this method proved quite effective. However, as a production method, acceptance as a satisfactory method of cutting did not occur. Problems of setup, economics, unreliability and general limitations of use made this method of questionable value except in specific cases.

As a modification of the waster strip, a fluxing rod was used, Fig. 5. A carbon steel rod was continuously introduced into the cutting stream where its burning and subsequent spray of molten metal initiated the reaction. Although set-up problems were reduced and some flexibility could be visualized, it was obvious that considerable skill of manipulation was required. In use with a hand torch, this appears particularly difficult.

In line with the foregoing methods, the metal for initiating the reaction occasionally has been in the form of a bead, laid by welding. The economics as well as general limitations previously indicated established drawbacks.

Recent Thermal Approaches

The earlier approaches, primarily thermal in nature, were all found to be lacking in flexibility or of poor economic balance even if they could perform actual cutting. A more recent approach which continues in principle from the foregoing is that of the introduction of iron

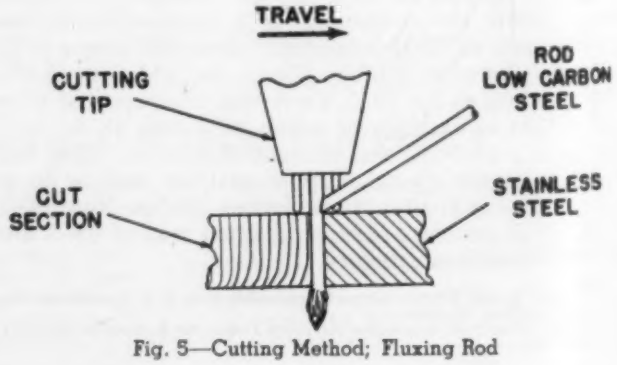

Fig. 5—Cutting Method; Fluxing Rod

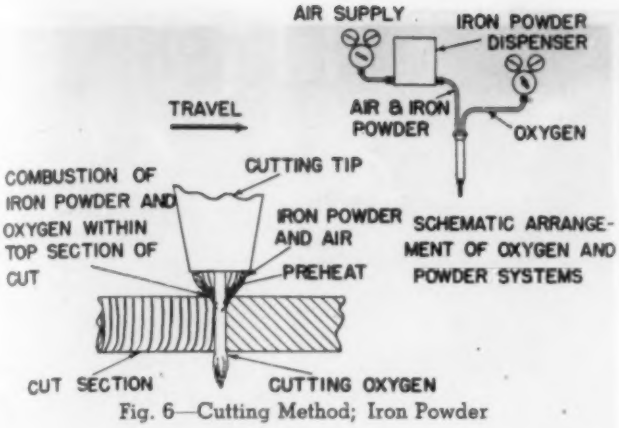

Fig. 6—Cutting Method; Iron Powder

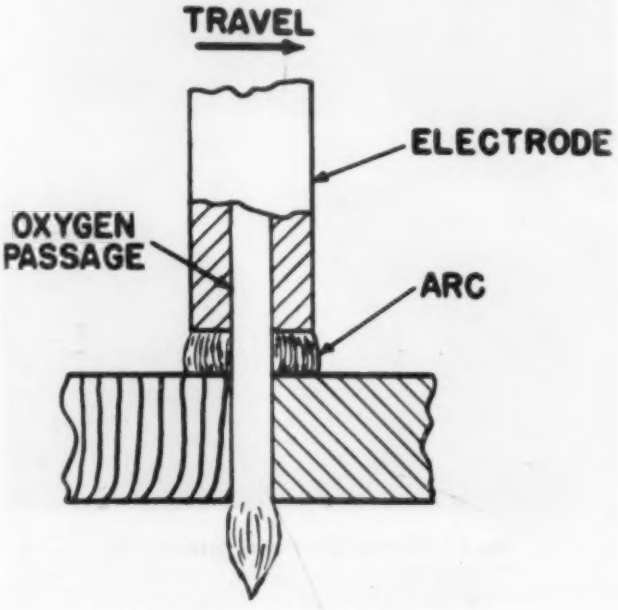

Fig. 7—Cutting Method; Arc-Oxygen

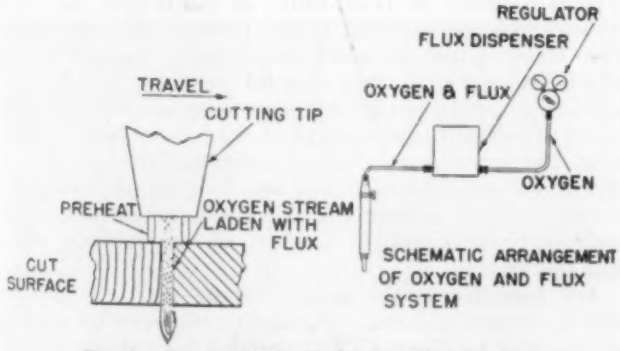

Fig. 8—Cutting Method; Oxygen-Flux System

powder for the generation of heat. This is portrayed in Fig. 6.

The iron powder is conveyed to the tip concurrent with the other torch requirements and upon exit, travels into and with the discharging oxygen stream. Combustion takes place prior to and upon entry into the stainless steel plate and establishes conditions which result in continuity of reaction. The powder is conveyed to the torch by an independent system which includes an appropriate means of controlling the powder quantity and characteristic of outflow. The carrier is a gas and is discharged along with the powder into the reaction zone. Just as accurate control of oxygen flowing conditions are necessary for good cutting on carbon steel, so also is it desirable to have similar uniformity of discharge for these added requirements.

Unlike the earlier approaches, the iron for auxiliary combustion is in this case governed by the torch and permits the familiar independence of torch and work piece. The powder unit, located remote from the torch, does require a source of dry gas such as air or nitrogen. Flexibility as required for production methods exists to almost the same extent as with ordinary cutting applications. The economics involve not only the familiar factors of gas consumption and operating speeds, but also the added factors incidental to the use of an auxiliary gas and metallic powder.

A second recent thermal approach exists in the use of a hollow electrode. The oxygen travels through the bore of the electrode, while the arc at the end surrounds the issuing stream. Limitations in size and detail of the cutting orifice together with an ever changing length of orifice as the electrode disintegrates, distinguishes the apparatus from conventional gas-type apparatus. For a uniform, well-controlled operation, producing good results, a uniform arc constantly surrounding the oxygen stream is necessary. Figure 7 portrays this method and is not unlike the use of extreme preheat, Fig. 2. Unlike

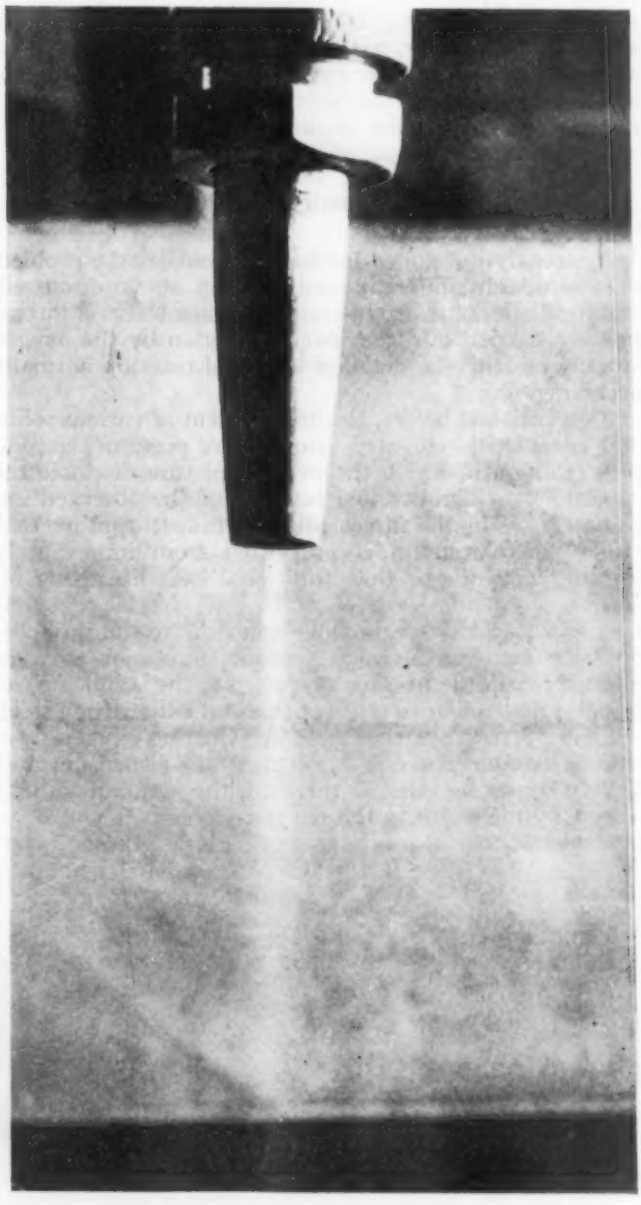

Fig. 9—Oxygen-Flux Cutting Stream

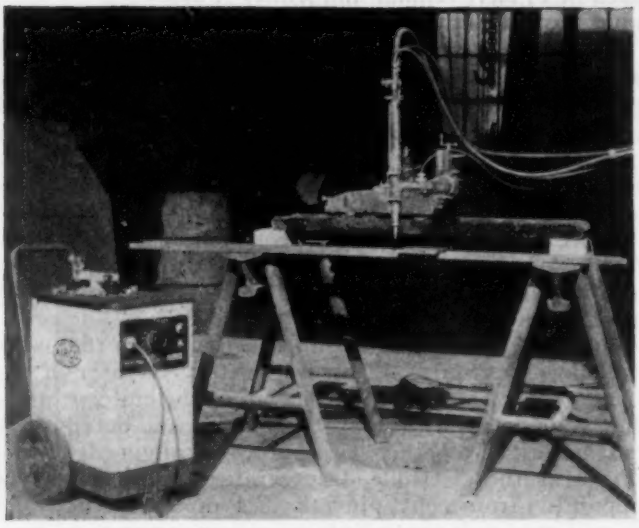

Fig. 10—Setup of Torch, Machine and Flux Injector

gas flame methods, no high temperature protective shield of burning gases is forced continuously into the kerf to minimize the chilling of slag. However, the oxygen stream and some air, heated by both the arc and the reaction, is drawn into the cut. This condition, while not serious with cuts on the lighter material, will become a deterrent in the heavier thicknesses.

Recent Chemical Approach

A recently developed method approaches the problem in a somewhat different manner than above discussed, and for distinction, can be classed as chemical. A fluxing powder, carried into the zone of reaction by the oxygen stream, adds to the detail of chemical reaction normally occurring.

As mentioned before, the involvement of various solids and gases at an elevated temperature presumes a complex reaction in which the over-all picture discloses the attainment of fluidity and removal of the observed impediments. In the intermediate detail, it appears that either the chromium is prevented from immediately forming an oxide or that additional heat liberating reactions occur, and by determining the probable reactions which can occur, it is possible to evaluate the probable final result. Of course, at present the major point of interest lies in the result which reduces the stainless steel in a manner similar to that experienced with carbon steel.

Figure 8 portrays this system. Cutting oxygen from a suitable source is conveyed to a flux dispensing unit and upon passing through this unit, the required amount of flux is injected into the oxygen stream. Upon leaving, this mixture of solid and gas is carried through conventional hose to a torch of the three-hose type. This type is required to avoid entry of solids into the small, critical passages existing in the preheat oxygen system. The torch must have cutting-oxygen valving means which are suited to theg as-solid mixture, and the passages in general must avoid restrictions, cavities and other detail which will cause erratic flow of the solids. Otherwise, the torch can be of conventional design, and, in fact, there exist familiar torches, long in use in general cutting, which answer the requirements exactly. The preheat, tip seat and tip itself are of conventional, available design.

The issuance of the powder along with the oxygen, Fig. 9, creates a degree of visibility that can be used by an operator to observe the nature of his cutting stream. The flux particles are ejected at a high velocity which assures their introduction into the zone of reaction.

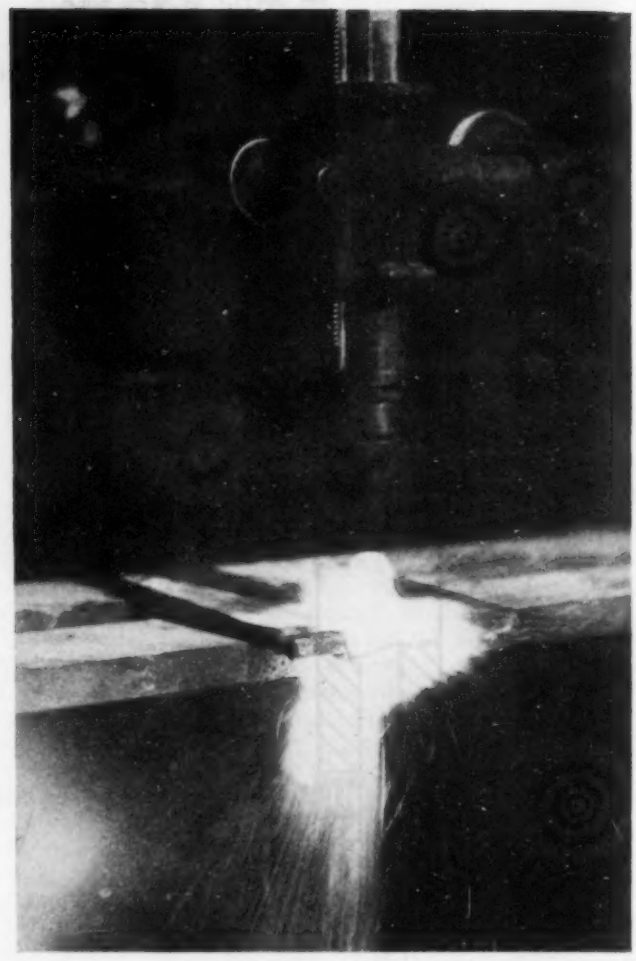

Fig. 11—Cutting Operation; Straight Line

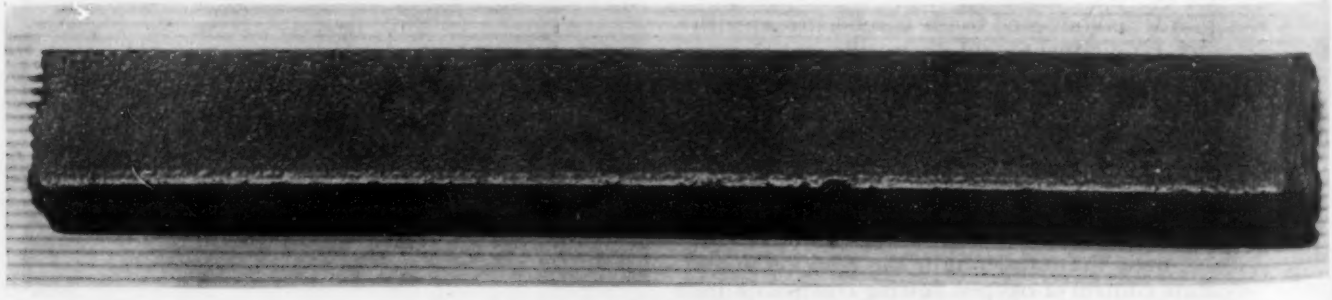

Fig. 12—Cut Surface, 1 In. Specimen

Mechanical Cutting—Flux Injection Method

A general arrangement of equipment for mechanical cutting is shown in Fig. 10 and is like any familiar setup except for the insertion of the "Flux Feeder." A remote control provision exists which eliminates the need for locating flux feeder at any specific point with relation to the cutting torch. The system for conveying the gas-solid mixture from the Flux feeder to the torch consists of regular hose and the avoidance of restrictive intermediate elements.

Fig. 13—Shape Cutting in Action

Fig. 14—Shape Cutting Product

The foregoing equipment in operation is shown in Fig. 11, the cut being made of 1-in. thick type 304 (18–8). No unusual detail is noticeable.

The resultant cut surface is shown in Fig. 12. This surface is straight and uniform and is similar to any high quality cut. A slightly heavier oxide film exists than is common with carbon steel and the drag lines are straight and not sharply pronounced. The kerf width existing during the cut is comparable to that obtained with carbon steel cutting.

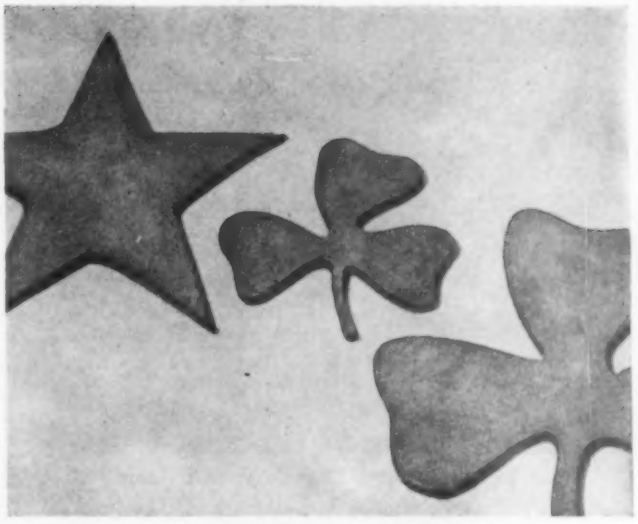

Fig. 15—Shape Cutting Product

Equally as well as straight line cutting, the performance on irregular contours can be made when using an appropriate machine to guide the torch. Figure 13 shows such an application on $^{3}/_{8}$-in. type 304. The result of this operation is shown in Fig. 14 with the curved product lying on the table. The production in this case totalled 880 lineal inches of cutting.

More difficult shapes with sharp points, re-entrant cuts and other fine detail have also been made although the very nature of operation calls for a careful control and well-suited equipment. Typical sections are shown in Fig. 15. It is apparent from such formations that no inherent impediments exist in so far as the reaction applies.

In addition to operations on plate sections, other applications respond satisfactorily. The removal of risers from castings has often been a problem due to size, physical shapes and mechanical equipment limitations. Figure 16 shows a typical casting with risers. By use of

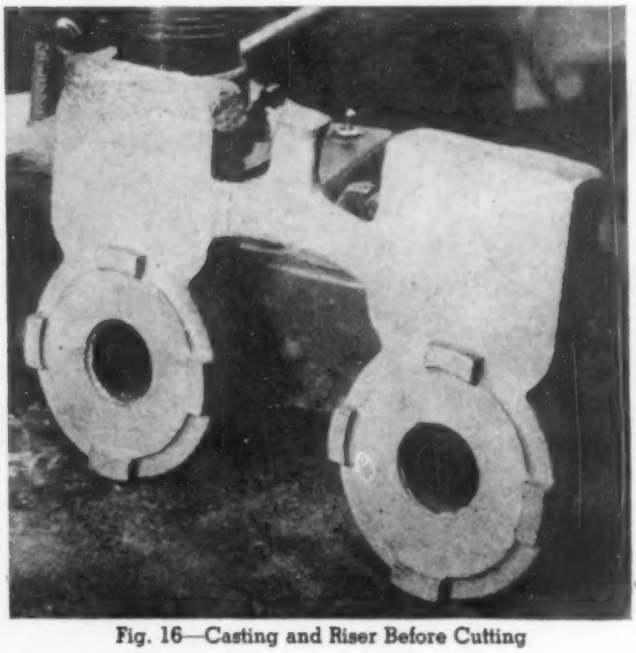

Fig. 16—Casting and Riser Before Cutting

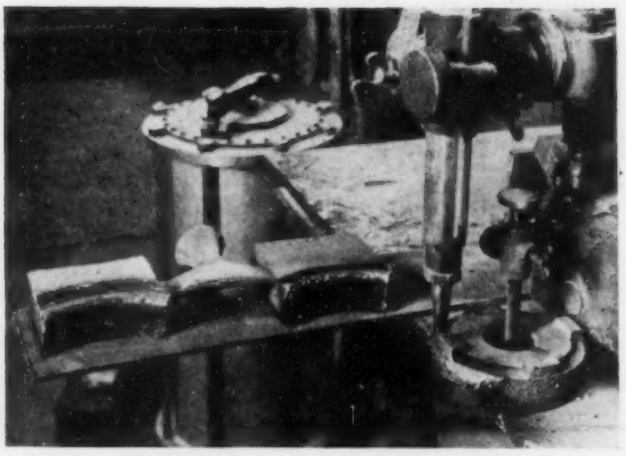

Fig. 17—Casting After Cutting Off Risers

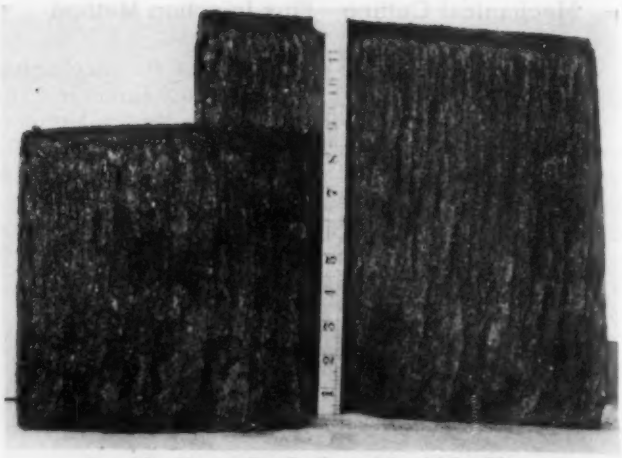

Fig. 18—Heavy Cut Surface, 12 x 12 In. Bloom

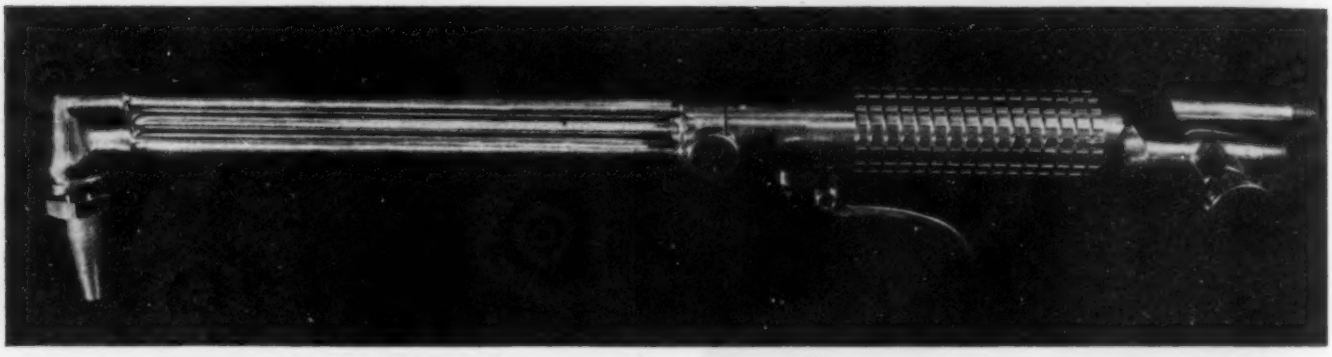

Fig. 19—Hand Torch

the cutting torch, the removal of risers leaves the desired castings, Fig. 17, trimmed closely to the final shape.

Not all stainless steel sections are of the relatively thin sections covered above. In the mill and in the scrap yard heavy sections are encountered which present serious problems and one at best, expensive to sever by mechanical means. Typical cut sections of a 12- x 12-in. type 304 (18–8) and of 9- x 9-in. type 316 (18–12) are shown in Fig. 18. The equipment was the same as that used on 1-in. material, Fig. 10, except that a larger size of conventional tip was used.

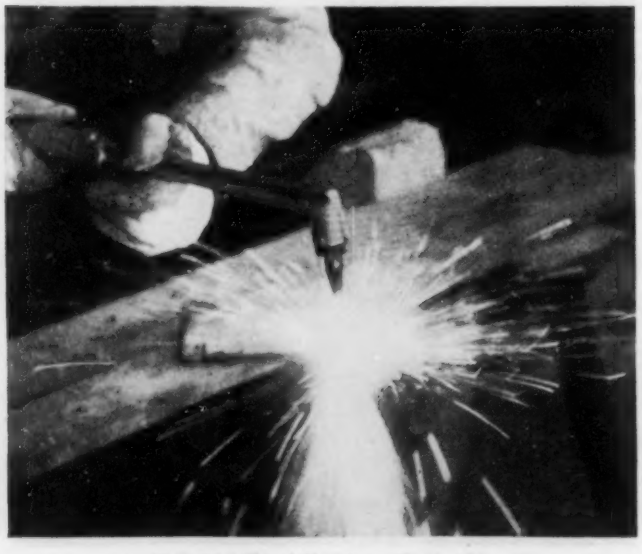

Fig. 20—Hand Torch in Operation

Hand Cutting—Flux Injection Method

While the preceding examples have been applications of machine cutting, the method is equally adaptable to hand operations when used with an appropriate hand torch. The over-all equipment requirements are identical and the torch must fulfill the previously mentioned basic characteristics, but adjusted in detail to accommodate hand utilization. A laboratory model of such a torch is shown in Fig. 19 and in general appearance presents no radical difference from conventional torches now in use in general hand-cutting applications.

The operation of this torch, Fig. 20, introduces no new problems of technique, although close observance of operational detail is important. Independence of the torch and flux source provides the familiar freedom inherent to oxygen cutting equipment. To insure the required control of the component parts of the system, effort was directed toward detail which would not impose more than the customary torch controls. This is of importance in hand operations where the valve is operated frequently and the operator is occupied with his torch and unable to closely observe other detail of his system.

A typical cut made with the torch mentioned above is shown in Fig. 21 and is not unlike the machine cut sec-

Fig. 21—Hand Cutting Product

tions previously shown except in detail related to the less uniform conditions of manipulation.

Comparison and Application

The general approach to the chemical process and incidental equipment for its performance has been premised on the assumption that the most broadly satisfactory result will be gained if a minimum deviation occurs from present established oxygen cutting practices. The process presents conditions of operation so similar to those now known that apparatus and operating technique are also very similar. The requirement for extensive operator training is thereby eliminated as well as the requirement for extensive innovations in shop facilities. A source of electric current and conventional gas supply permit activation of the apparatus. Adequate ventilation and personnel protection, a consideration with any form of oxygen cutting, was found to be important. The background of experience in the field of oxygen cutting was found to be of immediate value.

Operating conditions call for the attainment of approximately straight drag lines resulting in high quality with no uncut corner. Any comparison to carbon steel cutting conditions must bear this in mind and therefore will exclude some of the familiar data which surrounds the attainment of high speed, high economy, roughing type or other heavy drag producing cuts. The tips sizes, cutting oxygen and preheat requirements, as well as the adjustment of tip sizes and oxygen supply conditions, are all on the usual basis.

Although the present speeds of travel for cutting stainless steel are less than those used with carbon steel for thicknesses under 2 in., there is evidence that further experience and development will be able to reduce this difference. Heavier sections respond to about the same speeds. Different analysis of stainless steel can be expected to develop diverse cutting speeds.

In arriving at any economic evaluation, the foregoing discloses that usual considerations prevail and are adjusted to suit the specific problem. The only new factor is the flux requirement which ranges from $^1/_2$ to 2 oz. per minute.

The capacity of the Flux Feeder unit is such that for many operations, re-charging need not be more frequent than once a day. An over-all conservative rating for re-charge is $^1/_2$ day. While this permits re-charging at normal shut-down periods, it also provides for long continuity of operation without requiring an extremely heavy, bulky or nonportable Flux Feeder unit. Detail incidental to the flux, such as processing, packaging and handling, have been based upon the establishment of the fewest problems for the user which will still assure proper equipment performance.

Metallurgical

Since stainless steels are subjected to a wide range of heat treatments, and are sensitive to heat applications, it is natural to anticipate that consideration of the metallurgical effect from oxygen cutting will occur. As this process is of relatively recent introduction on a commercial basis, and since a wide range of compositions are involved, no extensive nor conclusive data are yet available. However, our present knowledge of heat effect will serve as a worth-while guide, particularly our knowledge of metallurgical effect from welding processes. Welding introduces rapid temperature elevation, rapid cooling and heat confined to a narrow band. The cutting process introduces a similar cycle, although the magnitude of temperature, time and distance may vary somewhat from welding.

Low-chromium air hardening stainless steels harden from welding, and would be expected to air harden within the heat-affected zone from cutting. Stainless steels of higher chromium content do not air harden from welding, but may undergo some grain growth. Cutting should have a similar effect. Chromium-nickel stainless steels do not harden, but unless stabilized may display carbide precipitation from welding. It has already been observed in cutting that unstabilized material gives rise to carbide precipitation as expected. The heating cycle from cutting, being a function of cutting conditions, can be altered only to a limited degree without affecting the cut. Some control can be applied to the cycle by such auxiliary methods as preheating or forced cooling, but the individual case will determine the advantages. In any event, any control means is to be avoided if it introduces detrimental effects on either the material or the cutting process.

Cutting before heat treatment is to be preferred if possible. Otherwise, subsequent heat treatment, or mechanical removal of affected material or acceptance "as is" will be necessary. If a subsequent processing may be affected by an altered surface condition, this fact must be considered and adjustments properly made. To say that cutting can be applied without regard to result would be a fallacy.

In the case of surfaces cut in preparation for welding, the metallurgical aspect of cutting is of little importance since the effect from welding is a far more important factor. However, any remaining oxide film should be removed to avoid inclusion of the oxide in the weld metal.

There has been a suggestion that with the introduction of a solid into the reaction, a combination of this solid with the metal might occur. No evidence has been disclosed which would indicate any combination of flux with the parent metal in the product. In the case of the early thermal methods where iron was introduced, some changes in composition balance might be expected at the surface, but the lack of commercial application limited the need and opportunity for study.

To sum up the metallurgical phase, known information on the effect of heat on stainless steel is the best source for reference. Case interpretations will be necessary for some time, and full appreciation must be given to the wide range of compositions; the magnitude of time and temperature; and the needs incidental to processing.

Conclusion

As with any process in its early stages, field use will bring about operations which cannot now be foreseen. Operators will develop their individual techniques and experiences through familiarity. Economic considerations will take various forms. At present, the cutting of stainless steel is a commercial reality.

The stainless steel industry now has the opportunity of utilizing a process which has proved its value in other fields. The relatively small equipment of versatile nature employed in oxygen cutting should be compared to the methods and equipment used for mechanical severance. The demonstrated savings in processing time should be considered in the light of general high cost of operation of present practices and in relation to competitive market conditions. This modern method of processing stainless steel offers solutions to many vexing problems.

Submerged Melt Welding in Pressure Vessel Fabrication*

By N. G. Schreiner†

A PRESSURE vessel may be defined as a container, generally cylindrical, which is fabricated according to certain specifications.‡ Even with these limitations, the classification of pressure vessels includes products such as air receivers which are connected to your filling station air pump, fuel-gas storage tanks of 100-lb. capacity, power boiler drums, and equipment for the chemical industry that operate at the highest possible temperatures and pressures. Despite this diversity, manufacturers are engaged in fabricating products which must be made to precise specifications and be subjected to exhaustive tests to determine their ability to function properly in service. Codes specify design, quality of materials, and fabrication procedures that have to be precise in order to meet dimensional tolerances of the completed vessel and insure soundness of the welded joints. Each step is tested to insure soundness of the unit. All of these tests are necessary because the high pressures and temperatures at which these vessels are operated constitute a hazard if a failure occurs due to an inadequate or defective part.

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† Manager, Unionmelt Service, Eastern Division, The Linde Air Products Co.

‡ Paragraphs U-68, U-69 or U-70 of the A.S.M.E. code, the specifications of the Interstate Commerce Commission, or equivalent governing specifications.

Advantages of Process

In precision work of this nature, it is not surprising that manufacturers sought methods of welding that would eliminate the personal element involved in manual arc welding. Submerged melt welding, an automatic electric welding process, has been adopted by at least 130 of these fabricators in fulfillment of this need.

Submerged melt welding besides assuring results brings about other advantages. Some of these are:

1. Faster rate of deposit of weld metal.
2. Increased output from a given plant area.
3. Increased return from plant investment.
4. Lower labor costs.
5. More favorable working conditions due to lack of fumes and flash.
6. Decrease in distortion.

In the pressure vessel field, submerged melt welding is used not only on the longitudinal and girth welds of the vessel itself, but also in the fabrication of nozzles, manholes and other fittings, and in the attachment of these pieces to the shell itself.

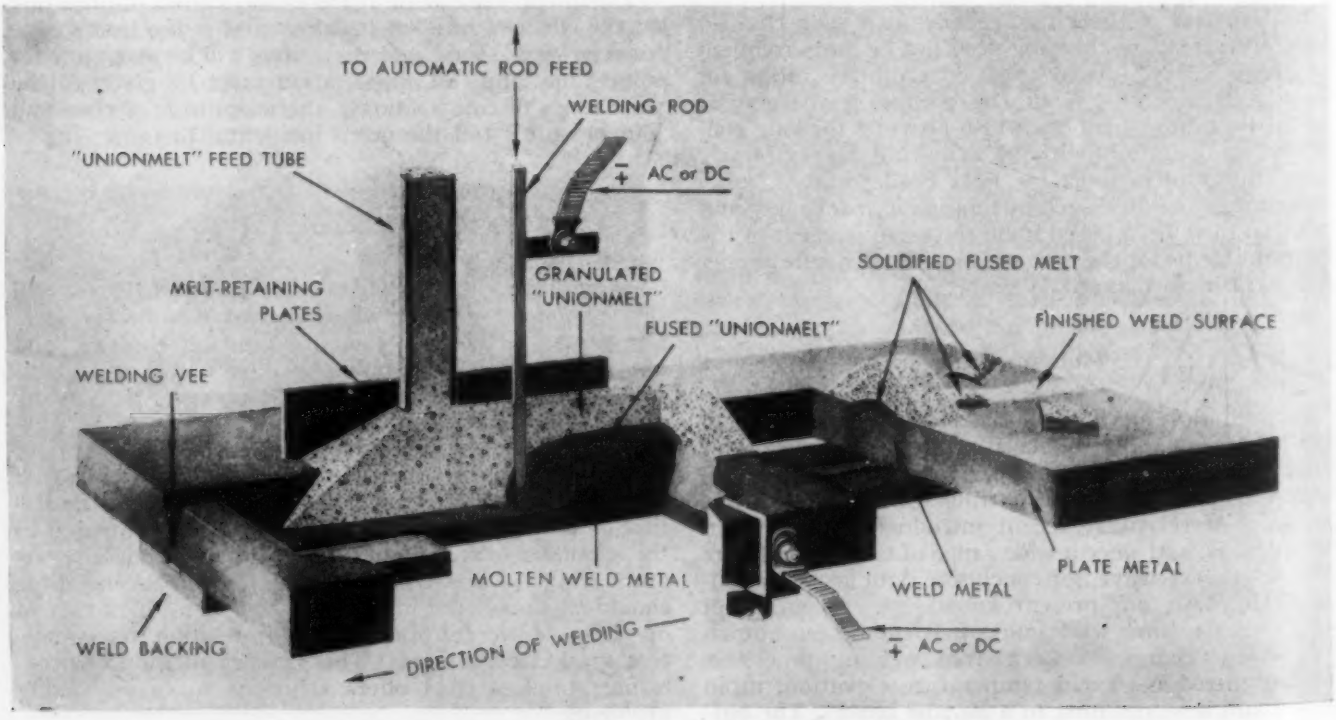


Fig. 1—Submerged Melt Welding Process Fundamentals

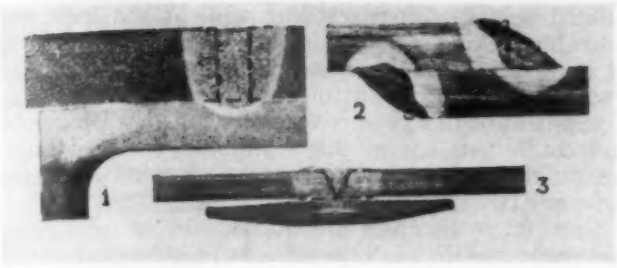


Fig. 2—Steel Backing Bar Butt Joints

Principles of the Process

The principles of submerged melt welding are illustrated in Fig. 1. The use of bare rod and the granulated mineral material, which submerges the molten puddle of metal and fused granulated material, permits the introduction of unusually heavy welding currents, up to 10 times those normally encountered in coated electrodes of similar diameter. The large amount of heat melts the rod and plate material rapidly, and accounts for the speed with which the joint can be completed. Since a large amount of material is molten at one time, it is essential that the weld be done in a horizontal or nearly horizontal position. For the same reason support of the molten puddle is also necessary. In this case a removable copper bar is used, but the support may also be a steel bar which becomes an integral part of the joint, a heavy root face, or a sufficient mass of manually deposited weld metal.

Preparation for Welding

Typical joint details are shown in Fig. 2, 3 and 4. Satisfactory results are assured by the fact that conditions have been established by trial on test plates of the same thickness of material. A typical table, shown in Fig. 5, has been prepared for a type of joint commonly used. Similar tables have been established for all commonly used joints. Joints so made will meet the highest requirements of the A.S.M.E. Power Boiler and Unfired Pressure Vessel Code and similar specifications. The same conditions would normally be used for welds not subject to x-ray inspection and will produce first-class results. The results therefore depend upon details which are physically observable and measurable rather than upon the manual dexterity and integrity of the arc welder. Recording voltmeters, ammeters, and tachometers can be used as checks on the conditions maintained and have been installed in a number of plants where such records seemed desirable.

The results of the process depend on maintaining welding conditions and joint preparation with reasonable precision. The edges may be prepared before forming by machining or by using the oxyacetylene flame so that they are uniform and straight. The edges should be crimped to the true radius, and the forming should be done either in bending rolls or a brake so that the edges are brought solidly together. On heavy-walled, small-diameter vessels, provision should be made when planing the bevels and nose to compensate for the distortion in forming, so that the noses fit parallel and the vees have the required angles. This allowance will vary somewhat with the forming facilities used. One well-known fabricator allows 4° for the distortion of the nose and bevels, of double vee joints on all vessels 54 in. diameter and less, and thicker than 1 in. This correction should be made on all long seam joints of cylinders within these

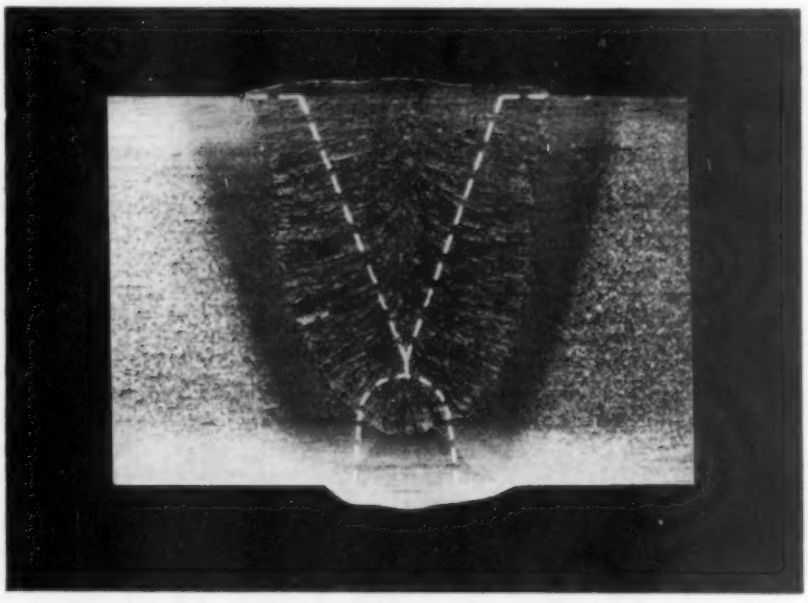


Fig. 4—Double-Vee Butt Joint with Manual Weld Backing

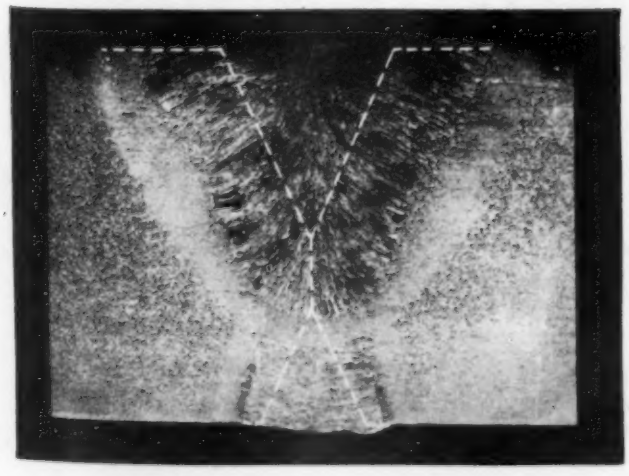


Fig. 3—Submerged Melt Double-Vee Butt Joint

dimensions, so that the groove after rolling is no larger than that called for.

With the plate straight and square and the forming adequate, the fitting should proceed without difficulty. For X-ray quality work, the tacks should be removed from the vee; in fact, fewer defects result if the tacks are never placed in the vee. This has led to at least two unusual procedures: the use of straps across the joint, and the use of bridge tacks. These are shown in Fig. 6. By these methods, the necessity for manual welding the root of the finishing vee is eliminated.

Fabricating Methods

There are two general methods of assembly in use for applying submerged melt welding. The first and oldest method may be called the "Step by Step" method, while the second may be termed the "General Assembly"

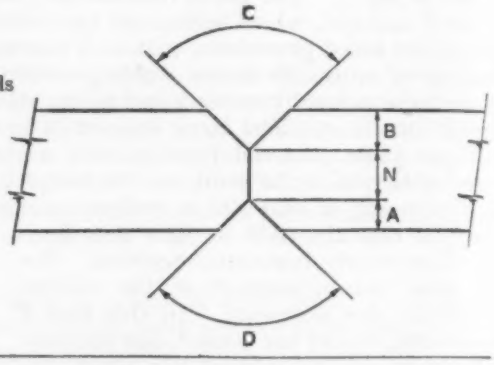
method. In the first method each course is welded inside and out as an individual piece. Each course is then fitted progressively to the adjacent course, and the inside seam welded as each course is fitted. This continues until the final closing section is reached. The inside seam at this point is welded manually. The vessel now being completely assembled and welded on the inside, is placed on turning rolls for welding the outside of the joints.

The welding apparatus for this type of construction usually consists of a rod-feed motor mounted on the end of a cantilever arm which, in turn, is generally supported on a stationary post. The vessel is supported by turning rolls mounted on a truck which can also travel at welding speeds. The arm should preferably be two courses long; thus two joints can be welded in one setup on the rolls. The method requires end tabs on each end of the longitudinal seams. Often rerolling and, at the least, considerable jacking of each course is required before it will fit its mate. This involves a large amount of handling from the welding to fitting position and back again. Equipment of this type is shown in Fig. 7. Economical and continuous use of this equipment requires careful scheduling of the many fitting operations and crane movements.

Since crane facilities are bottlenecks in most shops, and crane handling is expensive, it would be advantageous if the complete vessel could be fitted and tacked in a single position before it is brought to the welding station. End tabs on the individual long seams and rerolling of the individual courses would be eliminated. Submerged melt welding can be applied to a vessel assembled in this way by the use of a carriage type welding machine. For

Double-Vee Submerged Melt Welds

Typical Production Preparation and Welding Conditions for High Quality Welds
In Steel Conforming to A.S.M.E. Specifications S-42, S-44, S-55
For Grade 20 and 70 UNIONMELT 20x200 up to 1,500 amperes
Grade 20 and 70 UNIONMELT 20xD above 1,500 amperes
Grade 80 UNIONMELT 20xD for all currents



Finishing Weld								Backing Weld						
Thickness In.	Min. I.D. In.	B In.	C Deg.	Min. Amp.	Max. Volts	Speed In./Min.	Rod Diam. In.	N In.	A In.	D Deg.	Amp.	Max. Volts	Speed In./Min.	Rod Diam. In.
3/8	14	1/8	Chip*	600	33	20	3/16	3/8	0	0	550	33	22	3/16
1/2	14	1/8	Chip*	900	35	16	3/16	3/8	1/8	90	650	35	18	3/16
9/16	16	1/8	Chip*	1,000	35	16	3/16	3/8	3/16	90	700	35	18	3/16
5/8	18	3/16	90	1,050	35	14	1/4	1/4	1/16	90	750	33	16	1/4
11/16	20	1/4	90	1,100	35	13	1/4	1/4	3/16	90	800	33	16	1/4
3/4	21	1/4	90	1,150	35	13	1/4	5/16	3/16	90	850	33	16	1/4
13/16	22	5/16	90	1,200	35	13	1/4	5/16	3/16	90	900	33	16	1/4
7/8	24	5/16	90	1,250	35	12	1/4	5/16	1/4	90	950	34	15	1/4
1	24	3/8	90	1,300	36	11	1/4	5/16	5/16	90	1,000	34	15	1/4
1 1/8	24	3/8	90	1,350	36	11	1/4	3/8	3/16	60	1,050	34	14	1/4
1 1/4	30	1/2	70	1,450	36	10	5/16	3/8	3/8	60	1,100	35	13	1/4
1 3/8	32	1/2	70	1,500	37	10	5/16	7/16	7/16	60	1,200	35	11	1/4
1 1/2	36**	5/8	70	1,600	37	9	5/16	7/16	7/16	60	1,300	35	10	1/4
1 5/8	36**	5/8	70	1,700	37	9	5/16	7/16	9/16	60	1,350	35	9	5/16
1 3/4	36**	11/16	80	1,800	38	7	5/16	7/16	5/8	60	1,450	35	8	5/16
1 7/8	42**	3/4	80	1,850	38	6	5/16	1/2	5/8	70	1,500	35	8	5/16
2	42**	3/4	80	1,850	38	6	5/16	1/2	3/4	70	1,500	35	7	5/16
2 1/8	Long.	7/8	80	1,850	39	5.5	5/16	1/2	3/4	70	1,500	36	6	5/16
2 1/4	Long.	7/8	80	1,850	39	5	5/16	5/8	3/4	70	1,600	36	6	5/16
2 3/8	Long.	7/8	80	1,950	40	5	5/16	5/8	7/8	70	1,600	36	5	5/16
2 1/2	Long.	1	80	2,000	40	5	5/16	5/8	7/8	70	1,650	36	5	5/16

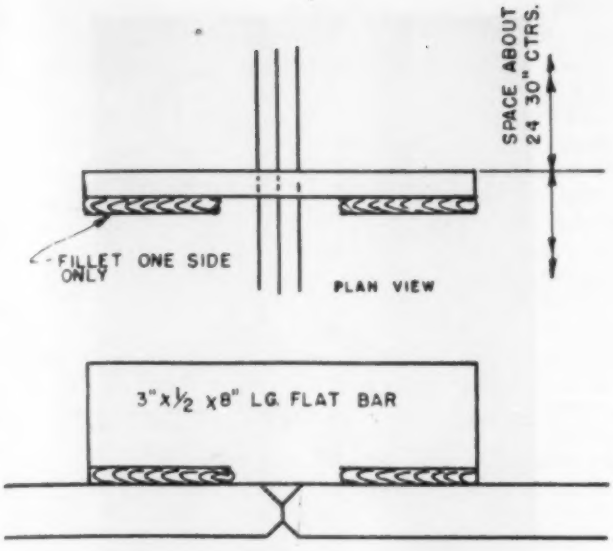
* Chip vee in second side after backing weld is made.

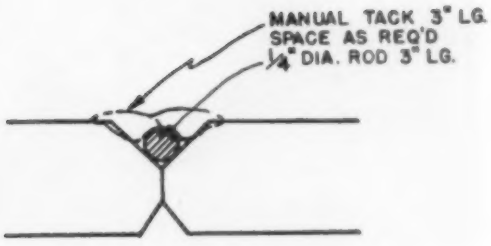
** For Grade 80 UNIONMELT Minimum Inside Diameter 48 inches.

Recommended Tolerances:

1. Gap between root faces—1/32 in.
2. N—plus 1/16 in. minus zero.
3. Misalignment between edges of root faces—1/8 in.
4. C or D—allowance must be made in edge preparation for distortion due to rolling.
5. Amperes used in first pass will vary according to fit up and should be maximum joint can carry.
6. Speed—to be varied slightly to secure desired reinforcement.
7. Check accuracy of meters frequently.

Fig. 5—Typical Table of Welding Conditions





JOINT STRAPS BRIDGE TACKS

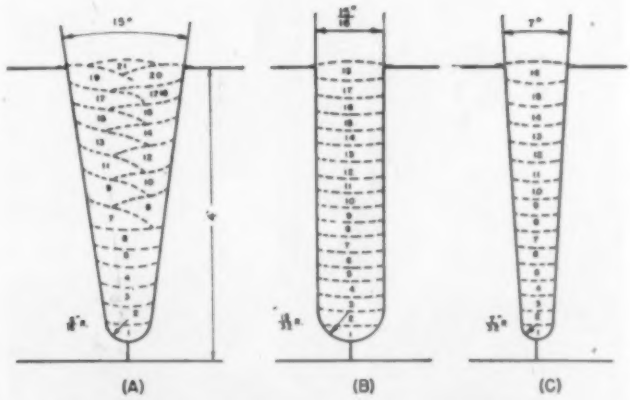
Fig. 6—Fitting Methods (Methods of Tacking Joints)

welding the longitudinal seams, the carriage straddles the joint and precedes the welding head. For welding the girth seams, the carriage is set off to one side of the joint, and is motor driven at welding speed. If the vessel is rotated on the rolls at the same speed in the opposite direction, the carriage remains at the bottom center of the vessel. Figure 8 shows the machine welding the inside girth seam of a tank 76 in. in diameter. Vessels with a manhole cutout at least 18 in. in diameter may be completely assembled, and the welding equipment introduced in two pieces through this opening. If the vessel consists of more than four courses, it is more advantageous to fabricate it in two halves, then join the two halves and introduce the equipment through the manhole for the final joint. If there is no nozzle opening large enough, the final weld must be backed by a manual weld or steel backing strip. While it would appear that placing the machine inside the vessel is a major operation, the period that actually elapses from the time the equipment is lifted from the floor to the time when it is in position ready for welding is generally less than 15 min. Operating factors as high as 70% (ratio of welding time to total elapsed time) are readily obtained by this method of operation.

The outside seams are generally welded by a stationary welding head mounted on an overhead structure, which provides a working platform for the operator. However,

Fig. 8—Carriage Mounted Machine Welding Inside Girth Joint

Fig. 7—Boom Mounting for "Step by Step" Fabrication



JOINT	9(A)	9(B)	9(C)
ROD REQ'D	13.2	11.8	7.7
ROD DIA.	5/16 & 1/4	1/4	5/32 & 1/16
NET WELDING SPEED FOR 4" JOINT IN MIN.	0.45	0.44	0.625

Fig. 9—Multipass Butt Joint Preparation

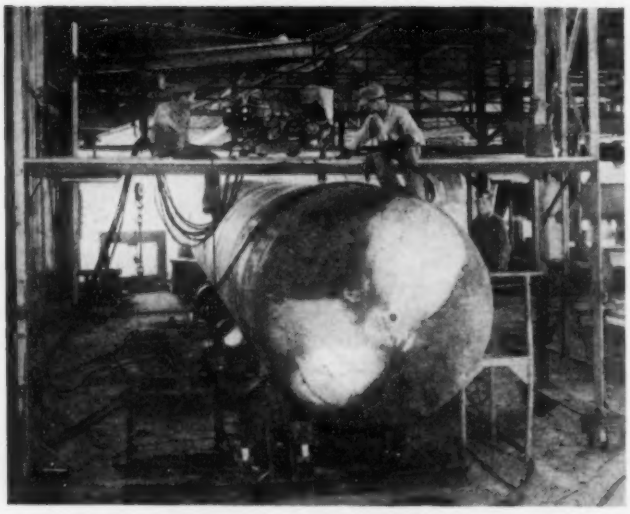


Fig. 10—Installation of Outside Multipass Welding

Man at the right operates chipping hammer to remove fused granulated material. Torch on left maintains joint temperature at 300° F. Vessel is 6 ft. diam. and 2 in. thick, made of S.A. 212B Steel

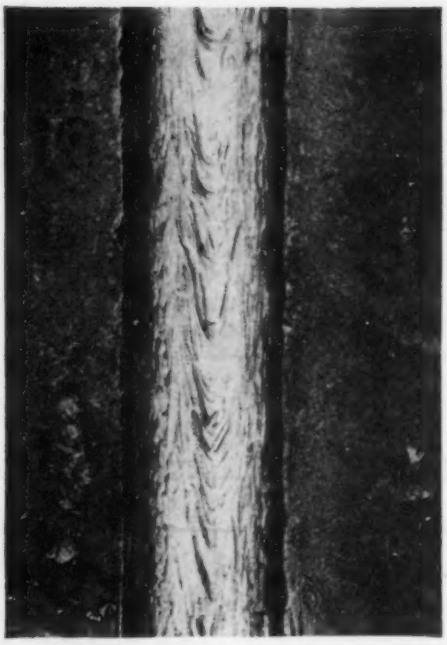


Fig. 12—Completed Third Layer-Fused Material Removed

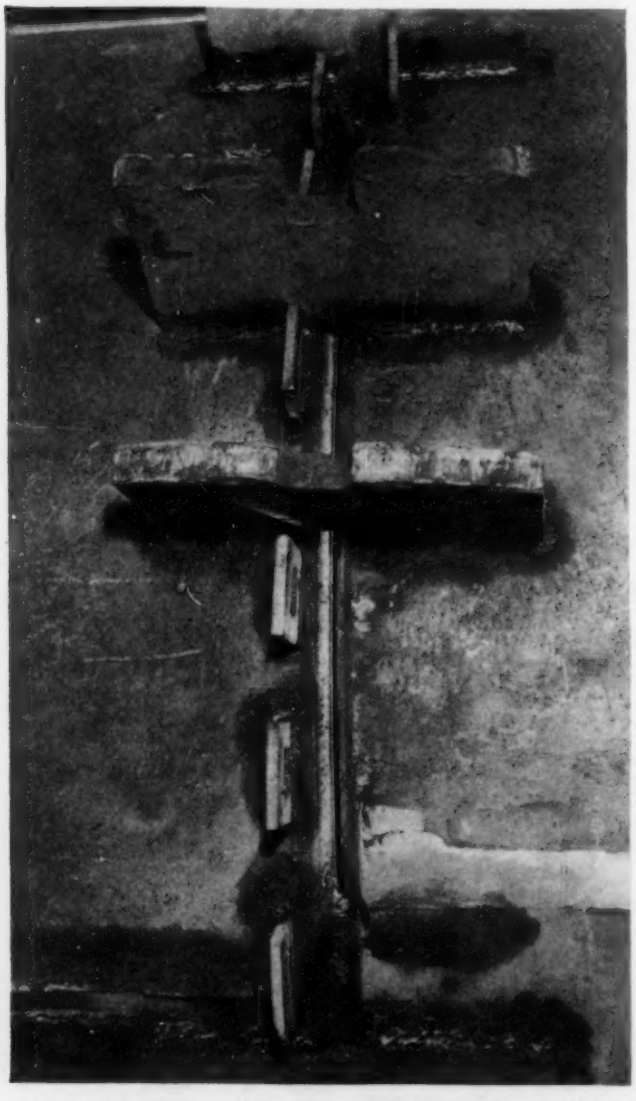


Fig. 11—Joint Prepared for Manual Back-Up Weld on Inside

Note root gap and line-up straps

the carriage type unit can also be used for welding the outside seams. Portable scaffolds are used to support the operators. The carriage should be loosely attached to some kind of support as a precaution against its falling off the vessel. This support may be either the scaffold or a jib attached to the building structure.

On boiler drums and similar small-diameter, long vessels, the longitudinal seam can be welded by either method. Since the diameter of these pieces is usually less than 54 in., the welding head must be supported on a cantilever arm if it is desired to weld the girth seams by the submerged melt method. Procedures have been developed for welding both heads by the submerged melt method, the rod being introduced through the manhole opening for the final closing joint. Other fabricators

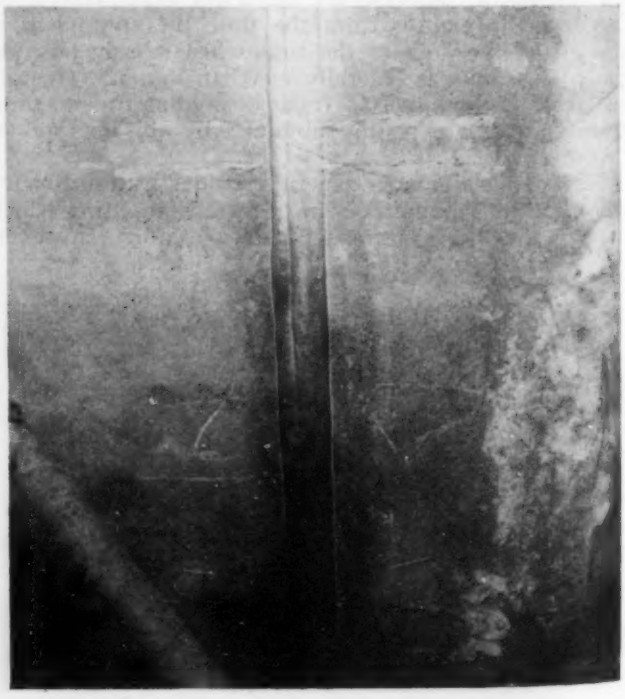


Fig. 13—Completed Joint—Final Layers Staggered

have considered it more economical to attach both heads with a manual backing weld and to complete only the exterior girth seams by submerged melt welding.

One of the problems encountered is the difficulty in controlling the molten metal and granulated material in welding the outside girth seams of heavy-walled small-diameter vessels. The limiting ratio of wall thickness to diameter for normal single-pass submerged melt welding seems to be approximately 1 to 25. For handling joints where the ratio is less than this, multipass methods have been developed. Typical multipass joint preparations are shown in Fig. 9. It will be noted that joint 9*A* has been taken directly from the joint detail in common use for manual arc welding. Since this preparation requires a large amount of metal deposit and is, therefore, time consuming and expensive, more economical joint preparations have been considered. Figure 9*B* shows a preparation with straight side walls that has been used on girth seams which are 5 in. thick. In addition to the smaller amount of metal required by this joint, only a single position of the rod is required from start to finish—that position being directly on the center line of the joint. Figure 9*C* shows another type of groove detail

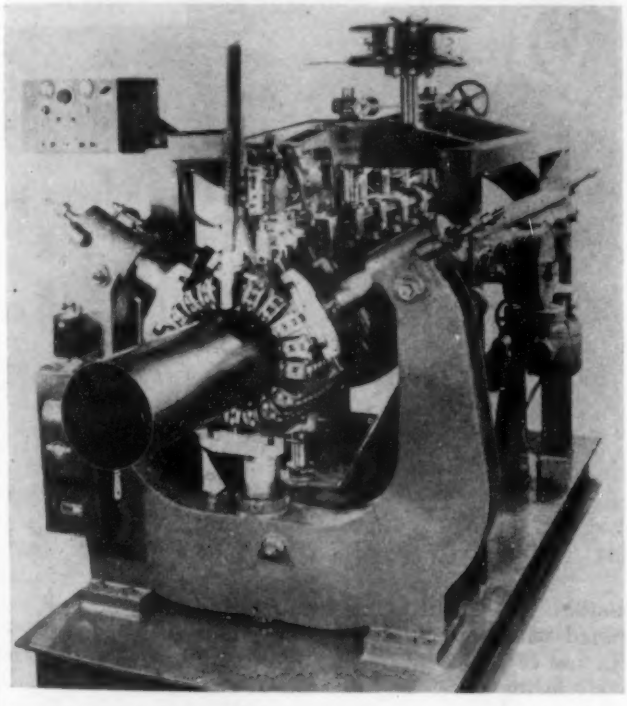


Fig. 14—Continuous Longitudinal Seam Welder

requiring considerably less weld metal and also less positioning of the rod during the deposit. Even smaller grooves than this have been used in joining two pieces of small-diameter heavy-walled tubing. The groove detail used in joining tubing of 5-in. I.D. and 1-in. thick wall resulted in a metal deposit of slightly over 1 lb. per foot at a net speed of 3 in. per min.

The rod and granulated material used for multipass welding have been selected so that suitable chemical compositions and physical properties of the weld metal can be obtained. A typical analysis of multipass weld metal at various levels in the deposit and the corresponding strength of the metal is shown in Table 1.

It may be interesting to view a sequence of photographs showing the various steps in depositing a multilayer girth weld. Figures 10, 11, 12, and 13 show the procedure adequately. The welding operation is continuous, since the slag removal takes place about 90° before the joint again reaches the welding head. This method makes use of many of the advantages of submerged melt welding, even though the currents are limited to approximately 1100 amp. The amount of reinforcing in the finishing passes can be closely controlled so that a very minimum of chipping and grinding is required. Manual arc deposited metal will require about 11 passes per inch of thickness, whereas the same thickness can be welded in three to four passes by submerged melt welding. The currents used are such that metal is deposited at an average rate of approximately 25 lb. per hr.

Preheating is recommended on heavy-walled vessels, especially on girth seams where the metal is in excess of $1^1/_4$ in. in thickness. This is especially necessary when high tensile steels, such as the SA-212 type, are being welded. The preheating temperature should be at least 200° F. and should be increased as the thickness increases, or as the diameter of the vessel becomes smaller, the thickness remaining essentially the same. An intermediate stress-relieving operation may be advisable

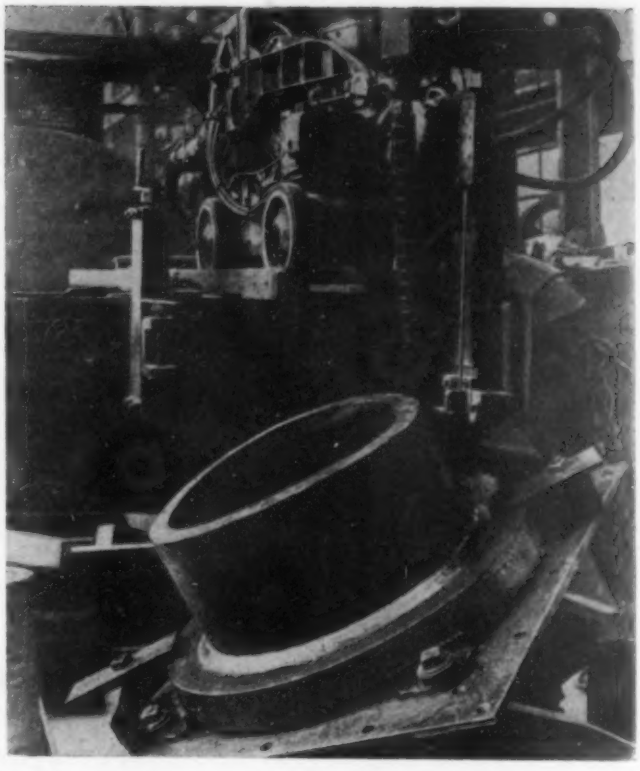


Fig. 15—Completing Outside Fillet on Fabricated Nozzle

Table 1

Position in Deposit	C	Mn	Si
Lower	0.092	0.94	0.30
Lower third	0.094	1.17	0.44
Top third	0.088	1.20	0.45
Top	0.076	1.23	0.45
Base metal	0.19	0.39	0.18

Tensile Tests

Typical Tensile Test Results of Multipass Welds
0.505 All-Weld Metal Specimen

	Lower Third of Joint		Top Third of Joint
Specimen From	As-Welded	Stress-Relieved	Stress-Relieved
Yield point	60,750	46,000 psi.	...
Ultimate strength	79,500	70,100 psi.	66,250
Elongation 2 in.	31 0	37%	31.0
Reduction in area	64.5	70.0%	65.5

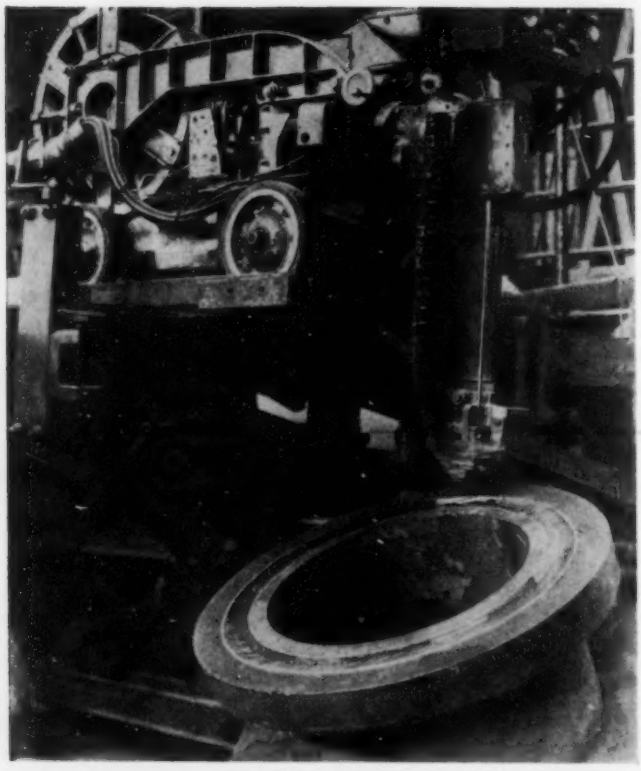


Fig. 16—Completing Weld on Flange Face of Fabricated Nozzle

at the half-way point of a single U-butt joint thicker than 6 in. to alleviate stress concentrations, although opinions differ on the need of such treatment. Single U-butt joints 5 in. thick in alloy steel have been produced in quantity with suitable preheat and without intermediate stress-relief. The larger instantaneous heat input of a submerged melt weld permits the use of lower preheat temperatures than are required for manual arc welding.

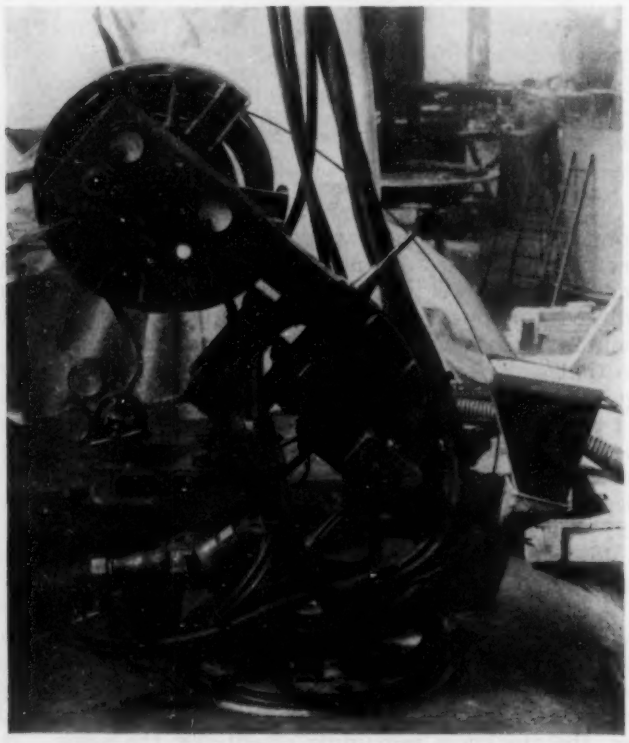


Fig. 17—Welder for Attachment of Bolting Ring to Shell

Single-pass submerged melt welds utilizing a copper backing have satisfactorily fulfilled the requirements of both Paragraphs U-68 and U-69 of the A.S.M.E. Code. Applications of this type are rather limited, but are most useful where a single product is being fabricated in mass production. An example at the present time is the fabrication of domestic propane storage tanks. The shell is formed and then passed through a welding machine which operates continuously. The type of machine is shown in Fig. 14. The weld is made against a water-cooled copper shoe as the shell passes the welding head. Because of the uniformity of the joint presented to the welding head, extremely high speeds can be obtained. As the shells emerge from the machine, they are separated by acetylene cutting. The heads are then attached, utilizing a steel backing strip in both ends. On

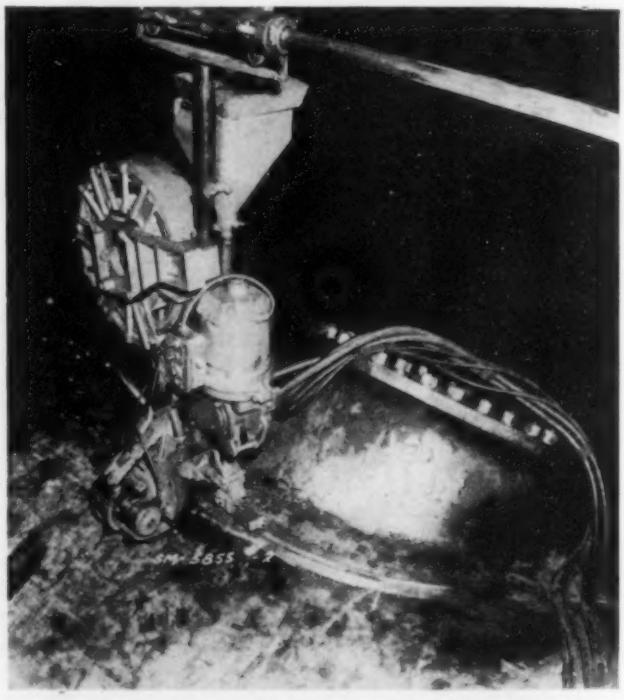


Fig. 18—Welder for Attachment of Dome to Shell

smaller vessels, the head may be inserted in the shell and joined with a circumferential fillet weld. In mass production of this type the head joints are made simultaneously, using a welding machine at each end of the vessel. Operating factors approaching 100% are commonly obtained.

Nozzles and manholes are fabricated by the submerged melt process using any one of the commonly available positioners for supporting and rotating the part underneath a stationary welding head. The head is generally mounted on an elevating table and also provided with a horizontal adjustment, either by means of a carriage or a custom-built slide. The nozzle is best supported on the positioner table by means of a universal chuck, since in this way it can be most easily centered, although other methods of mounting have been devised. The neck and flange, should be machined to insure a cylindrical surface and obtain a tight fit. Multipass methods are generally necessary because of the small diameters and the size of the welds required by the Code specifications. However, in a well designed setup, the average rate of metal deposited is 20 lb. per hr. Hence nozzles can be fabricated with economy in cost and manpower. Figures 15 and 16 show the setup and results obtained in this operation.

A very unusual application of the process has been the attachment of nozzles and other devices to the shell. The problem is essentially one of directing the welding machine at constant speed around the path of the weld which is defined by the intersection of two cylinders. Figure 17 shows one analysis of this problem and is suitable for cases where the diameter of the attachment is small in relation to the diameter of the main body. Figure 18 shows a piece of equipment which was devised for welding domes to locomotive boilers. There is always a considerable mechanical design problem to be worked out before the process can be applied to joints of this type. The various savings as well as the higher quality of deposit that is possible in these applications of submerged melt welding have led many fabricators to develop such special equipment.

There are, of course, many factors entering into the fabrication of pressure vessels by submerged melt welding which have not been discussed. Some of these may be considered as major problems by some fabricators, and intensive research is being directed toward their solution. Most of the problems are, however, simply details which have had to be solved by all of the fabricators now using the process to their economic advantage. The economic advantages of automatic submerged melt welding, even when limited to the more easily accomplished longitudinal and girth seam welding, have proved so attractive to pressure-vessel manufacturers that some 130 fabricators of this class of equipment have adopted the process. This includes the largest companies and many of the smallest.

We extend our appreciation to the fabricators who have permitted the use of photographs of their equipment as illustrations for the subject matter, and for the cooperation of the various groups who have made this discussion possible.

An Oil-Powder Method of Flaw Detection*

By Bela Ronay†

PARTS of prime movers and other equipment are frequently inspected at the U. S. Naval Engineering Experiment Station in course of the periodic disassembling performed in connection with testing to determine the suitability of various types of equipment. The purpose of these inspections is to detect whether or not any defect has developed in the form of cracks or other types of surface discontinuities. The inspection is applied in part to protect the safety of the operating personnel and also to determine the serviceability of the equipment under test.

The inspection requested consists of X-raying certain parts, but most frequently the desired examination concerns the detection of cracks and other surface flaws in machine parts whose complexity and size renders them unsuitable for X-ray examination.

The most generally practiced method of surface flaw detection, the use of magnetic powder, requires the employment of highly trained technicians particularly in such complex structures as Diesel engine frames, crankshafts, reduction gears, cylinder heads and other machine parts of comparable size and construction. Engineers familiar with the application of the magnetic powder method of testing will appreciate the difficulties which confront the applicator of this procedure in such complex structures as Diesel engine frames where the failure generally occurs at the sharp intersection of two members, or where sudden changes of wall thickness are of frequent occurrence. Likewise, in examining a heavy Diesel crankshaft particular care and skill must be used, not only in the method of magnetization but in interpretation of the powder pattern to distinguish between those caused by the presence of flaws and others which form at sharp edged cheeks and other points of redundancy or sudden change of cross section where magnetic flux concentration occurs and develops false indications.

The fluorescent oil methods of examination are not readily applicable to Diesel engine frames or other heavy objects partly by reason of lack of accessibility for the use

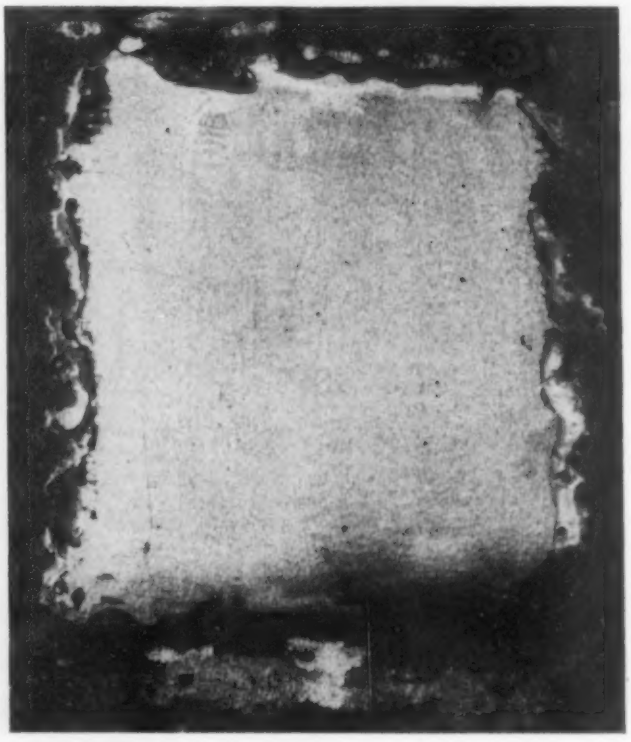


Fig. 1

* The author's opinions and views presented in this paper do not necessarily coincide with those of the Navy Department.

† U. S. Naval Engineering Experiment Station, Annapolis, Md.

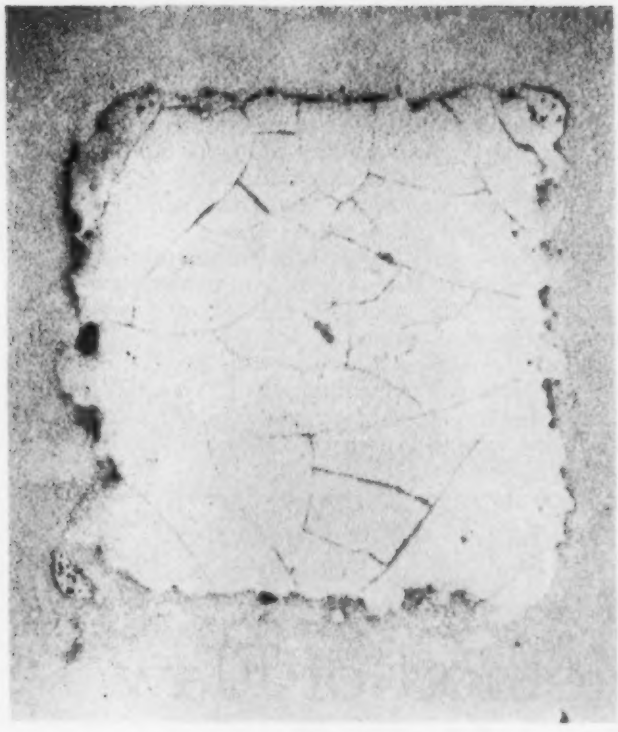


Fig. 2

of the ultraviolet light and partly the lack of means efficiently to apply the oil; then, too, it is not always practicable to transport the object to be examined into a chamber where the required semidarkness can be maintained. Another serious drawback in the use of the fluorescent oils, particularly in connection with test work, wherein the development of defects must be recorded, lies in the fact that it is impracticable to photograph fluorescent flaw patterns.

The desire to provide a means for the detection of surface flaws whose application can be entrusted to laboratory technicians and others of like qualifications and which can be readily photographed. led to the develop-

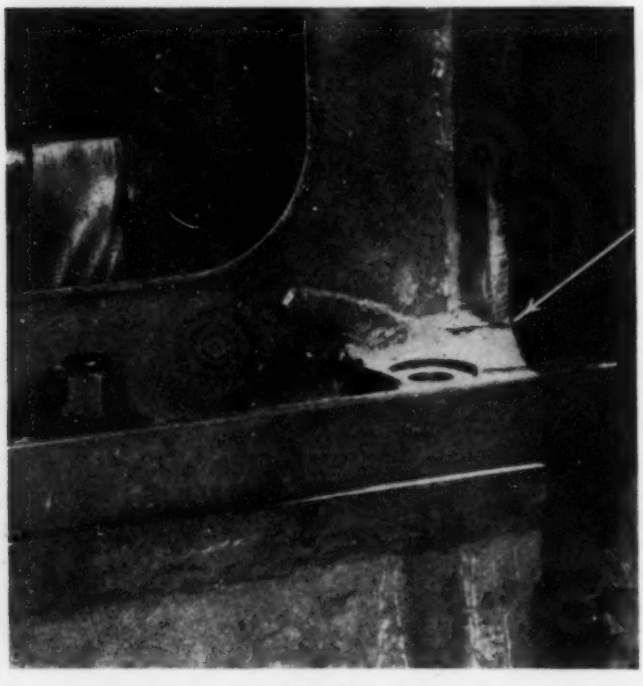


Fig. 3

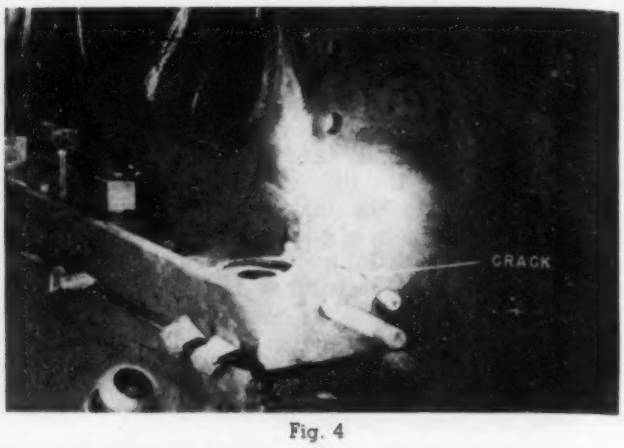


Fig. 4

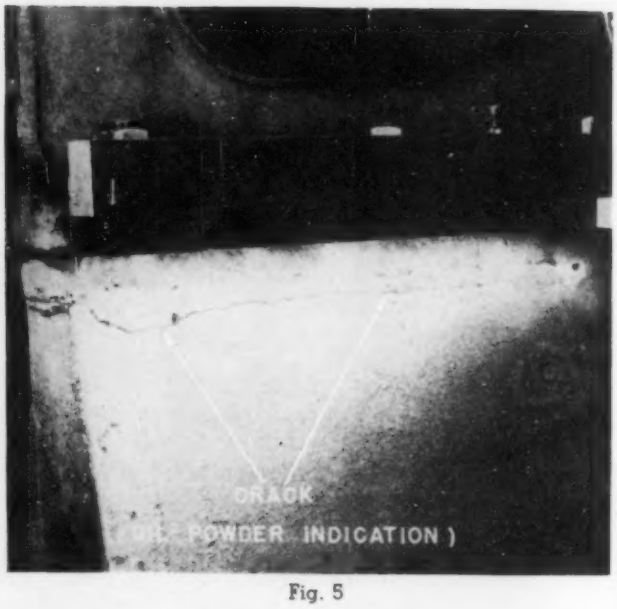


Fig. 5

Fig. 6

ment at the U. S. Naval Engineering Experiment Station of a method of inspection capable of satisfying the above requirements. From a survey of the description and the subsequent application of the various types of nondestructive tests claimed to be suitable for detection of surface defects and their appraisal in view of the above requirements it appeared that the old time kerosene and whiting test should be explored and investigated in regard to the factors which render it slow and ineffective for the detection of minute flaws.

The results of this investigation showed that the penetrant must have very low surface tension to permit propagation into tight cracks by capillary action and must have the property to penetrate into crevices containing moisture. In order to obtain indication of minute flaws the detector must be in the very finely divided state and must be highly hydroscopic to absorb even traces of moisture. Inasmuch as trapped moisture may occur in irregular surfaces, such as rough machined parts, the penetrant must be identifiable by a distinctive color to avoid the possibility of false indications.

The above problems were presented to a petroleum engineer attached to the Experiment Station who conducted an investigation which led to the development of a penetrating oil which was found to fulfill our requirements. The oil was compounded with a deep red dye which immediately identifies the flaw pattern as a defect, as will be noted on reading the method of application.

The detector agent also developed at the Experiment Station is a white powder of air floating fineness.

The method of applying the above ingredients for surface flaw detection is given in the following:

1. Throughly clean the surfaces to be examined with either tetrachloride of carbon or Stoddard's solution, whichever is permissible on the object, applying the solvents liberally by means of a well-soaked cloth.
2. After the application of the solvent remove the excess with a dry cloth.
3. Apply the penetrating oil by means of an atomizer, spraying on a sufficient quantity to assure full coverage in the form of a continuous film of oil.
4. Leave on the oil for one to one and a half minutes.
5. Wipe off the oil with a dry cloth.
6. Wipe the surface, again employing a clean cloth *moistened* with the earlier used solvent to remove all traces of the penetrating oil not previously removed.
7. Apply the white powder with a powder applicator or a "rag doll" duster.
8. In the event that there is a crack or any other defect terminating on the surface, the pattern thereof will appear in less than one minute in a sharp deep red line against the dull white background.
9. Photograph within a few minutes while the outline of the defect is sharp, using orthochromatic film.

The photograph on Fig. 1 shows a hard surface overlay deposited on a steel plate, and surface ground. This overlay was then fractured by heavy blows on the far side of the plate. The fractures are of fine hairline quality, not discernible in direct visual examination, though experienced inspectors may detect their presence by slanting the surface at an acute angle which reveals the presence of the cracks by refraction.

Figure 2 shows the cracks contained in the above overlay as revealed by oil-powder inspection.

Figures 3, 4 and 5 show fractures in Diesel engine frames detected by means of oil-powder inspection.

Figure 6 shows an inspector's kit containing the following items:

1. 8-oz. bottle of Tetrachloride of Carbon.
2. 8-oz. bottle of Stoddard's Solution.
3. 8-oz. bottle of penetrating oil.
4. Can of detecting powder.
5. Atomizer for applying the penetrating oil.
6. Rag doll for applying the detecting powder.
7. Illuminated four-power magnifier.

The oil-powder method of flaw detection, described above filled our requirements in that it can be applied in all positions; it requires neither skill nor any auxiliary apparatus for its application. The interpretation of the defect pattern is direct. Any pattern appearing against the white background of the powder film which does not show the tell-tale deep red color is not a defect indication, but a warning of a job not properly executed and serves as an automatic check for the methodical application of the procedure.

The defect indications can be photographed, and in the event that the photographic apparatus is not available at the time the defect is revealed, within the hour the defect pattern can be re-developed in full sharpness by wiping off the original powder and re-dusting the area to be photographed as the camera and lights are being set up.

Finally, another distinct advantage of the oil-powder method of flaw detection is that it can be applied with equal ease to ferrous materials, either pearlitic or austenitic, to all nonferrous metals and, indeed, it has been applied with full satisfaction to plastics.

Production Applications for Inert Gas-Shielded Arc Welding*

By H. T. Herbst†

Introduction

HELIARC welding is The Linde Air Products Company's new and different kind of electric arc welding that employs a sheath of inert gas to protect the virtually non-consumable tungsten electrode and weld puddle. It differs from atomic-hydrogen welding in that the arc is formed between the tungsten electrode and the work, instead of between two electrodes; and the protecting shield is inert and therefore non-reactive with the molten metal. This new type of welding with argon or helium is sometimes referred to as "inert gas-shielded arc welding." The main features of the Heliarc process are shown in Fig. 1.

While an inert gas protected arc process was the subject of laboratory research a number of years ago, it was not extensively used until during World War II. First accepted commercially for the fusion welding of magnesium, it is now widely used to weld a number of other "difficult-to-weld" metals and alloys, such as stainless, high-carbon, and other alloy steels, aluminum, brass, Inconel, Monel, Everdur and pure silver. An outstanding feature of the Heliarc process is that all of those metals can be fusion welded without the use of any flux—an accomplishment which has never before been possible by any other welding method. In addition, it can be used to braze pure silver and silver alloy coatings on steel, stainless steel, and aluminum, and for the deposition of hard surfacing materials.

Thus, since 1942, Heliarc welding has undergone considerable development and improvement, with tremendous expansion in the usefulness and scope of the process. During this time, employment of argon in place of helium as the inert shielding gas has demonstrated several distinct advantages. Argon is the only gas known today that is suitable for economically welding, by this process, aluminum as well as most all of the other commerically used metals and alloys. Moreover, the purity of argon available through commercial supply channels is maintained at a uniformly high level. This is significant because both the efficiency and reliability of the process depend in large measure upon freedom of the shileding gas from hydrocarbons, moisture or oxygen.

In operations where helium and argon have both been used separately, it generally has been found that equivalent amounts of welding require only $^1/_2$ to $^1/_3$ as much argon as helium. Thus, although the initial cost per cu. ft. or argon is slightly higher than helium, the over-all cost of welding is considerably less when argon is employed. In general, comparative use of the two gases in production shows that hand-welding operators also prefer argon for ease of control, particularly when welding thin material.

* Paper presented at Twenty Seventh Annual Meeting, AMERICAN WELDING SOCIETY, Atlantic City, N. J., Nov. 17–22, 1946.

† Development Engineer, The Linde Air Products Co.

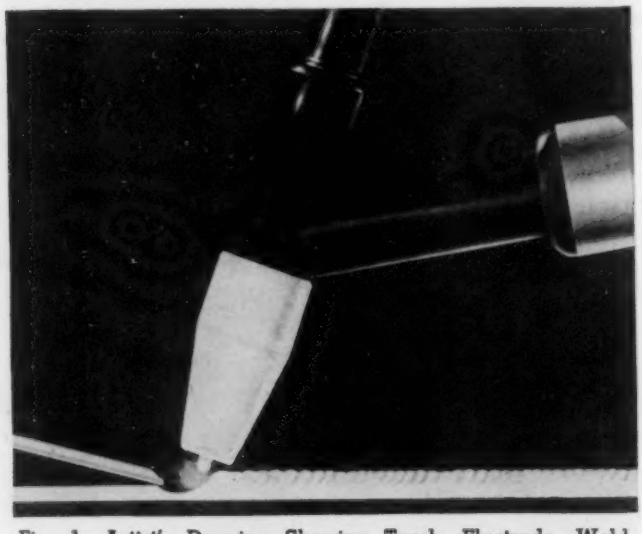


Fig. 1—Artist's Drawing Showing Torch, Electrode, Weld Puddle and Welding Rod

Welding Torch

Originally designed for work largely on magnesium, the Heliarc torch was meant to be operated on direct current with reverse polarity up to a maximum of about 125 amp. For this purpose the early torches were quite satisfactory.

However, with the application of the process to other metals, and the development of new techniques using much higher currents and also high-frequency stabilization currents, it was necessary to make certain changes to provide greater ruggedness and insulation without sacrificing lightness and maneuverability of the instrument. Development work on this problem led to a design that included complete insulation and water-cooling. This design has been available from stock for about a year. Under conditions of present day usage, the non-water-cooled type of Heliarc torch is entirely outmoded except for light and intermittent duty.

Figure 2 shows, in cross section, the main construction features of the internal parts of the present torch. Fitted to the rear of the handle are three lengths of hose, with these functions: the first supplies argon; the second supplies cooling water; and the third serves as an outlet for the cooling water and also carries the power cable. The argon flows through the body of the torch into the rear of the gas chamber, which also serves as a receptacle for the unused portion of the tungsten electrode. A replaceable electrode holder is fitted to the front of the gas chamber by a threaded connection. Holders are provided for electrodes that are $^1/_{16}$, $^3/_{32}$, $^1/_8$, $^3/_{16}$ or $^1/_4$ in. in

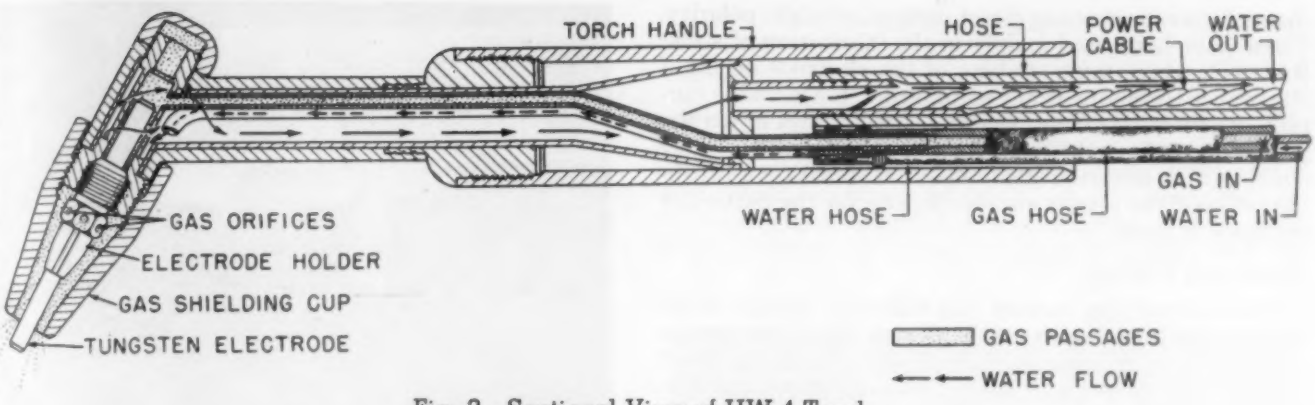


Fig. 2—Sectional View of HW-4 Torch

diameter. The cooling-water inlet hose connects to a copper tube that circulates water throughout the body of the torch, providing efficient cooling that gives comfort to the operator and long life to the torch parts. The water flows through the body of the torch to the hose containing the power cable.

Because the power cable is thus completely surrounded by water, it is possible to carry extremely high currents on a relatively small, light, and flexible cable. With a water flow of less than one pint per minute, the torch has a nominal maximum rating of 250 amp., although it has been used at currents as high as 350 amp. To protect the torch against overheating in case the water supply fails, a fuse assembly inserted in the cable circuit automatically shuts off the power. This fuse makes use of the standard replacement cartridge-type links.

Safety precautions for Heliarc welding are similar to those for metallic arc welding. The operator should wear a standard arc-welding shield, gloves, and heavy work clothing, and should have his sleeves rolled down. Some of the illustrations show operators without all this recommended apparel because individual users of the process don't always follow safety recommendations to the letter.

Direct Current, Reverse Polarity

Investigation of current characteristics for Heliarc welding had an important bearing on the advancement of the process. In the first commercial applications of Heliarc welding on magnesium, the power used was direct current, reverse polarity. This was satisfactory for welding magnesium, but not for most other metals. The major disadvantage is that when direct current, reverse polarity is used, the melting point of the tungsten electrode is reached with a relatively low current density. Thus, the maximum current which may be employed on a 1/4-in. diam. electrode is approximately 125 amp. The limit for smaller diameters is proportionately less. When these current limits are exceeded, the end of the electrode forms into a fluid ball that ultimately leads to contamination of the electrode with the weld metal or vice versa.

Power Requirements

Direct Current, Straight Polarity

The use of direct current, straight polarity, results in much less heating of the electrode, but is unsatisfactory on aluminum and magnesium. Direct current, is, however, very suitable for stainless steel, copper and nickel alloys, and for brazing and hard facing. For these applications it gives greater penetration or speed than alternating current.

Carbon electrodes have been used for easy starting in

Fig. 3—Chart Showing Recommended Current Values

Recommended Welding Current Values

Electrode Size, In.	Current Range, Amp. A.C.H.F.	D.C.S.P.	D.C.R.P.
1/16	40–120	75–150	10– 20
3/32	100–180	100–250	15– 30
1/8	150–240	200–400	25– 40
3/16	250–360	350–800	40– 80
1/4	350–475		80–125

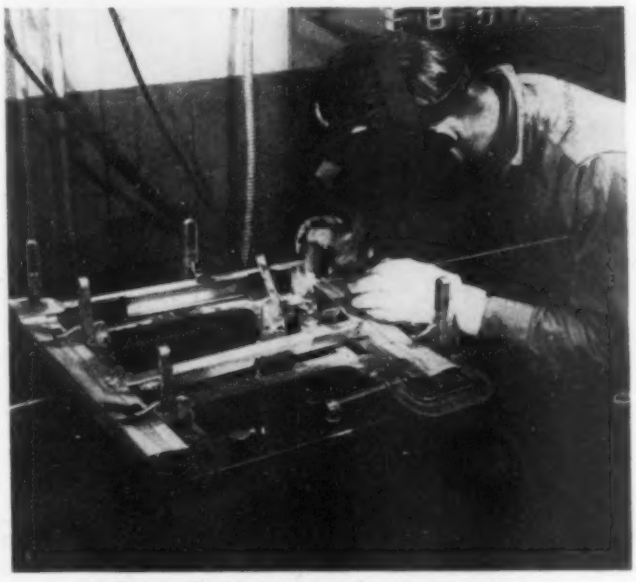


Fig. 4—Welding Magnesium Aircraft Seat

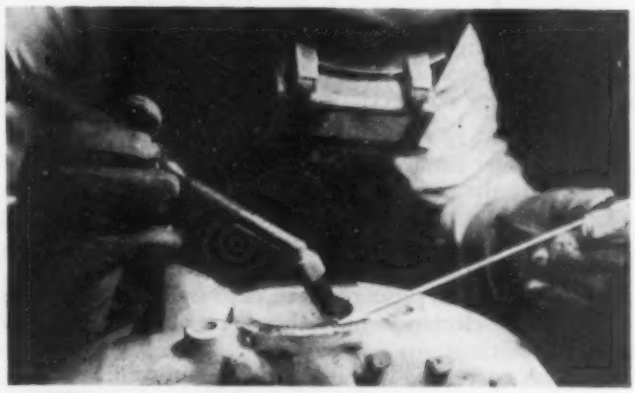


Fig. 5—Method of Handling the Torch and Welding Rod in Repairing a Magnesium Casting

manual operations using direct current, straight polarity. These have been used mainly in the fabrication of stainless steel, where some sticking of the electrode occurs if the proper technique is not employed. Since undue current densities on carbon electrodes will result in carbon addition to the weld, their use is questionable. Easy starting with tungsten electrodes is attained by a brushing action if the proper current density for the particular electrode is used.

Alternating Current

When alternating current was tested for Heliarc welding, it caused less heating of the electrode than the reverse polarity, d.-c. connection, but its use resulted in great difficulty in starting and in maintaining an arc, particularly in low-amperage ranges. To overcome this, there was introduced the use of high-frequency stabilized, alternating current which had been used previously as a means for starting low-amperage hand welds by the metallic-arc process. Standard generating equipment was therefore available from several sources, with the high-frequency stabilizing current supply as a built-in feature. In general, these transformers are similar to standard welding transformers, except that they contain high-frequency current-generating units. The current developed by these generators is superimposed on the standard welding current.

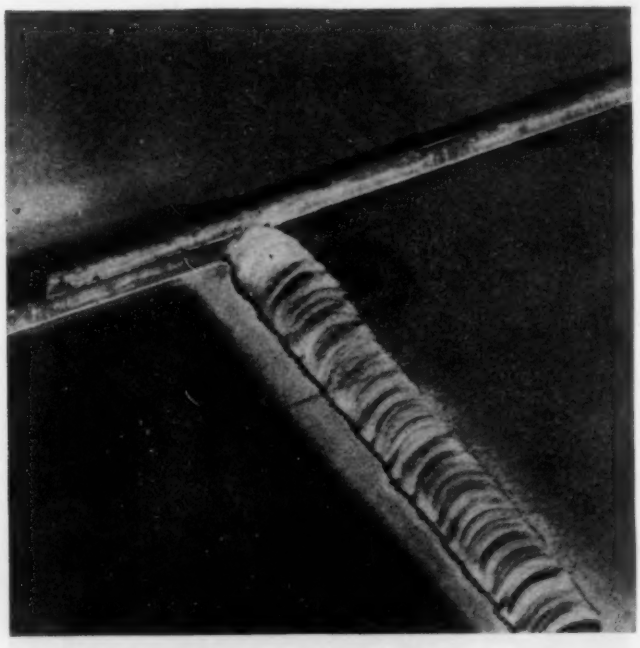


Fig. 6—Lap Weld on Aluminum

The advantages of alternating current with superimposed high-frequency current over direct current with reverse polarity connections are as follows:

1. Starting is easier.
2. A longer arc length can be maintained, thus making the process less critical.
3. No flux is needed on any weldable metal, providing argon is used.
4. There is less electrode heating.
5. There is less pickup of the weld metal on the tungsten electrode and therefore cleaner weld deposit.
6. Less current is required for a given weld.
7. The electrode life is increased as much as 100%.
8. Position welds can be more easily made.

Fig. 7—Overhead Corner Weld on Aluminum

The advantages of high-frequency stabilized alternating current over direct current, straight polarity, are not so numerous. However, the alternating-current welding does produce easier starting so that less metal is picked up on the tungsten electrode. The main advantage of a. c. over straight polarity d. c. is that the latter cannot, at the present time, be used to weld aluminum or magnesium without flux.

Other materials on which alternating current has been found to give suitable welding characteristics are stainless steel, high-carbon steel, beryllium copper, bronze, Monel, silver and brass, with the exception of some leaded varieties. Such alternating-current welding employs that type of current that is available from standard hand- or machine-welding transformers. This means an open-circuit voltage of from 55 to 100 v.

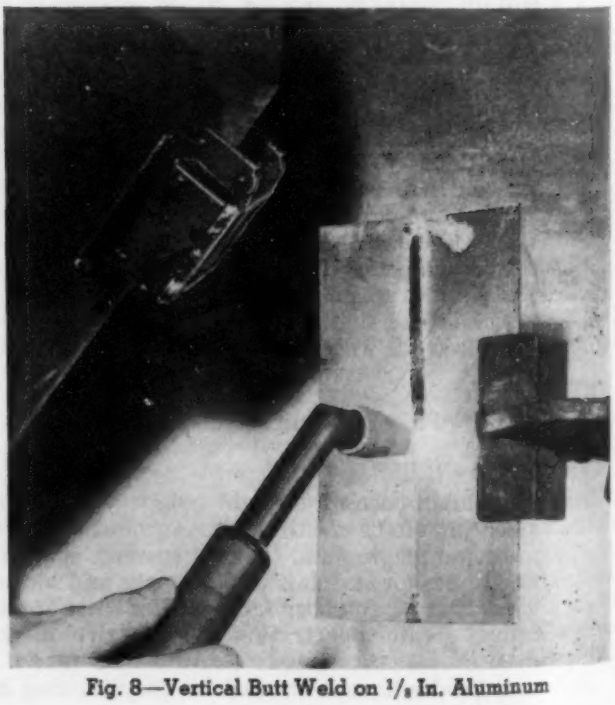


Fig. 8—Vertical Butt Weld on 1/8 In. Aluminum

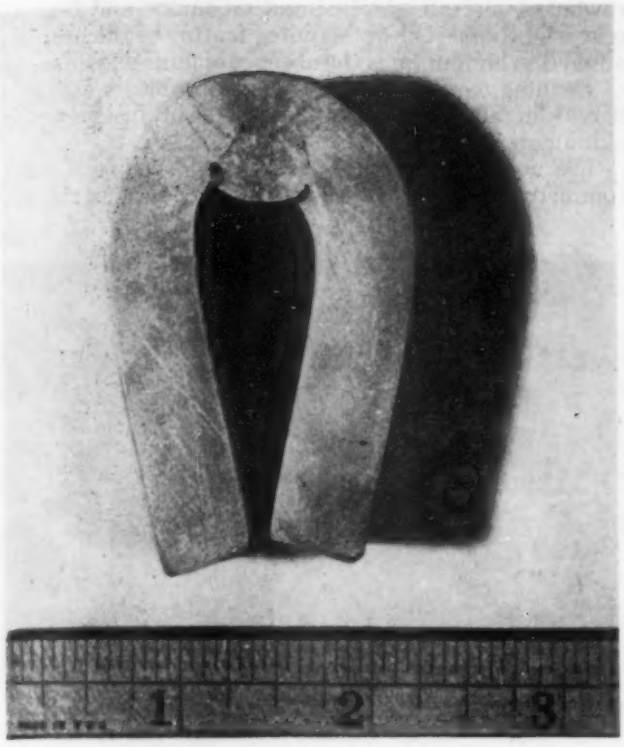


Fig. 9—Face Bend 61SW Aluminum

In addition to the use of welding transformers with superimposed high-frequency built-in, it is quite practical to use regular welding transformers of the unstabilized variety. These may be adapted for high-frequency operations by the addition of a high-frequency generator in the current leads. A type of high-frequency unit found quite satisfactory for the purpose is that which is ordinarily supplied for quick or hot start in manual arc welding.

The table in Fig 3, listing the approximate current carrying capacities of the standard size electrodes, summarizes the welding condition for various types of current.

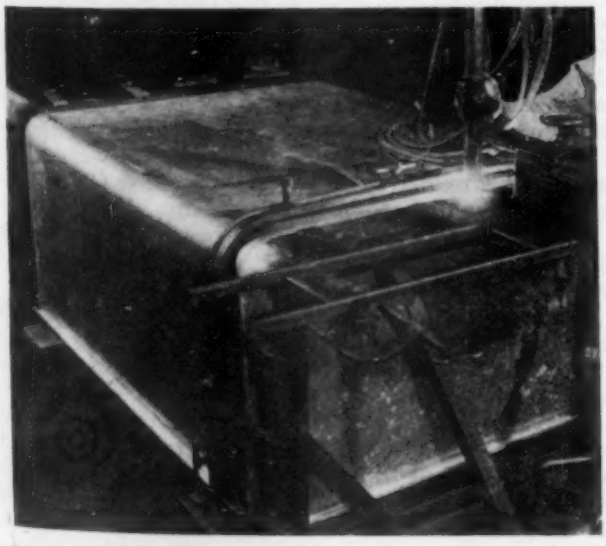


Fig. 10—Mechanized Welding of Aluminum Powder Buggie Without Flux

Production Applications

Magnesium

The use of Heliarc welding on rolled as well as cast sections of magnesium influenced the rapid growth of the use of this material, particularly for aircraft during the war. Such items as fuel tanks, aircraft seats and aircraft structural assemblies were fabricated from magnesium tubing and sheet by means of Heliarc welding.

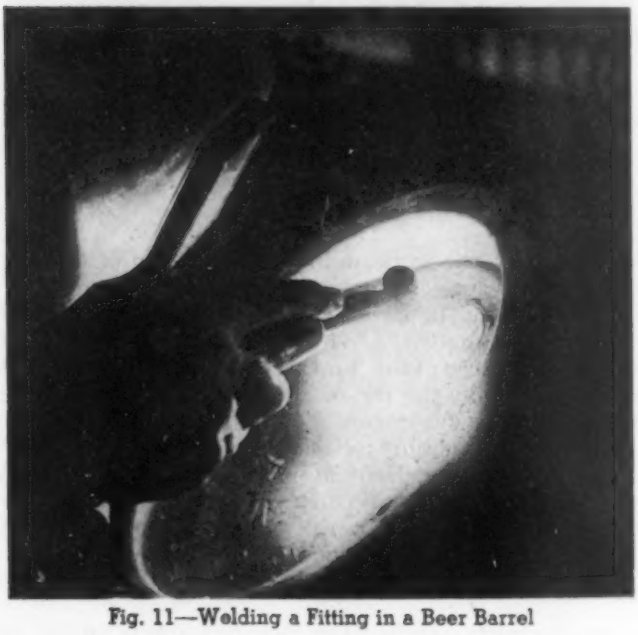


Fig. 11—Welding a Fitting in a Beer Barrel

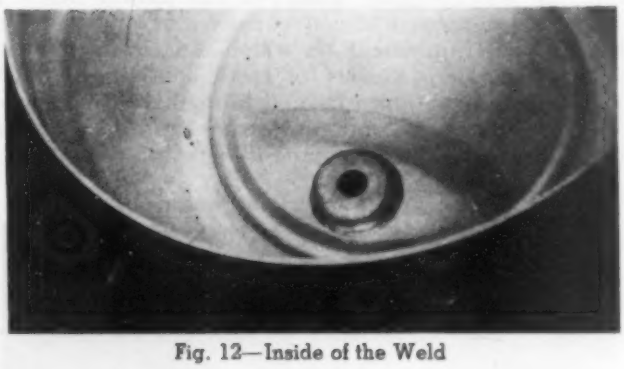


Fig. 12—Inside of the Weld

Figure 4 shows the welding of an end frame of an aircraft seat. The metal used here is magnesium FS-1. Some other types of magnesium alloys successfully welded by the Heliarc process are C, G, H, J-1 and M.

Large savings can be effected through the repair of magnesium castings by Heliarc welding, shown in Fig. 5. Furnace preheating ordinarily varies from 2 hr. at 725° F., for the most critical work, to shorter periods at 300 to 400° F. for simple sections or less critical parts. Average argon consumption for this type of work is about $2^1/_2$ liters per minute, or $5^1/_2$ cu. ft. per hr. of torch operation. The approximate rate of metal deposition is 0.4 lb. or 7 cu. in. per welding hour. These rates are for the relatively slow reverse polarity, direct current method of welding. The alternating current method, now gaining in favor, allows deposition rates of from 2 to 4 times as great as before in the heavier sections. This gain is made at little or no increase in gas cost, but results from added

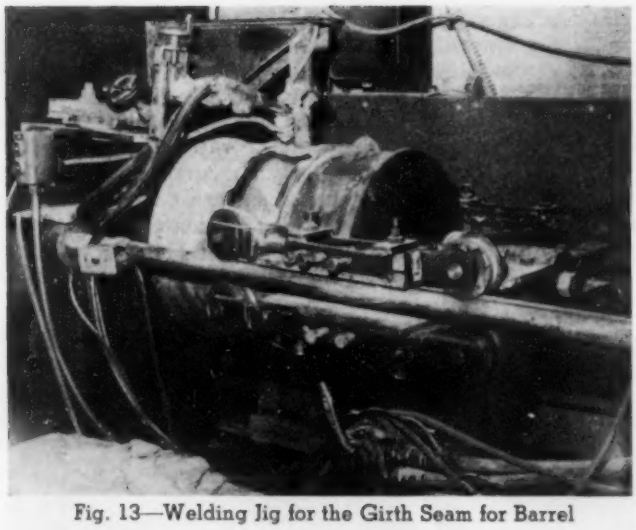


Fig. 13—Welding Jig for the Girth Seam for Barrel

heat input to the work and reduced heating of the electrode when using alternating current.

The choice of the Heliarc process for magnesium welding has been almost 100%. Corrosion problems associated with the use of flux on this metal are so great as almost to prohibit the use of a welding process requiring flux, except for emergency repairs.

Alloys of magnesium, offering the obvious weight-saving advantages that they do, are expected to find many new uses. Undoubtedly, where fusion welding is indicated, the Heliarc process will play an important role in the use of these relatively new commercial alloys.

Aluminum

In aluminum welding, the Heliarc torch is finding its greatest application as an industrial tool. In some cases, it is the only possible means of fabrication, while in others, its economy and convenience make it almost indispensible. Equipment on which it is being used includes large storage vessels for acetic acid and hydrogen peroxide, railway tank cars and locomotive cabs, explosive powder cars and containers, ship cabin sections and hatch covers, radio and radar cabinets and components, rowboats, aircraft gasoline and oil tanks, and beer barrels. Of course, the outstanding feature of the process as applied to aluminum is the absence of flux and elimination of cleaning, corrosion and porosity problems always inherent in all other known methods of fusion welding aluminum.

The non-heat-treatable alloys that have been welded commercially by this process are 2S, 3S, 52S; of the heat-treatable alloys, 24S, 53S and 61S have been successfully welded. Figure 6 illustrates the typical clean, bright surface appearance of a properly made Heliarc weld on aluminum. This is a lap weld without weld metal. For lap welding without weld metal, the parts must be held in close contact; otherwise, weld metals must be added.

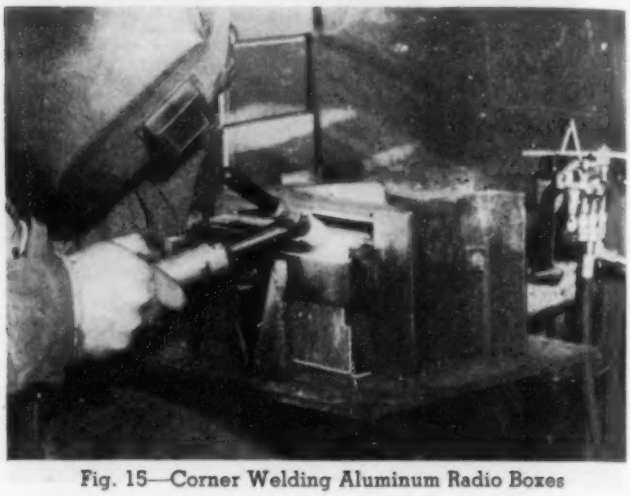


Fig. 15—Corner Welding Aluminum Radio Boxes

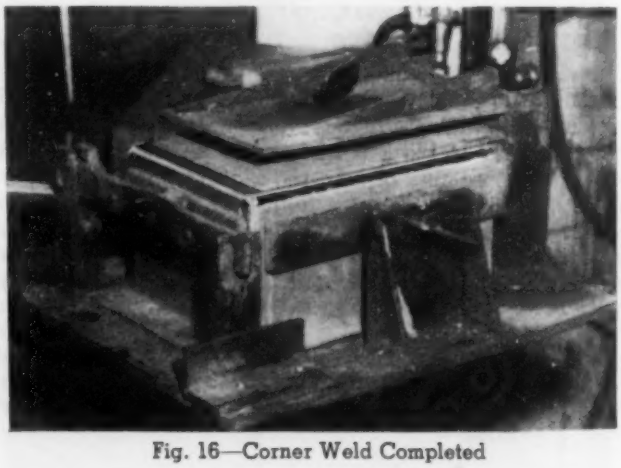


Fig. 16—Corner Weld Completed

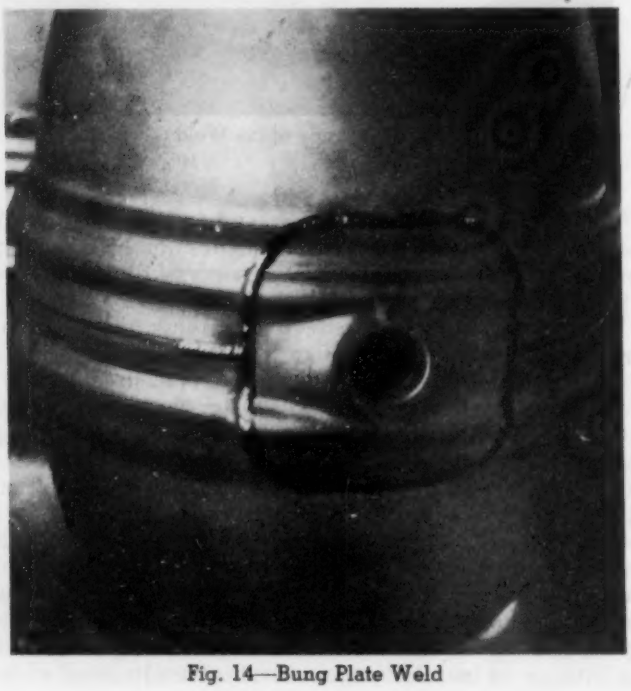


Fig. 14—Bung Plate Weld

Figure 7 shows a 2S aluminum plate, 0.125 in. thick, being corner welded in the overhead position. The welding rod is made of $^{3}/_{32}$-in. 2S aluminum.

Figure 8 represents a butt weld being made in the vertical position on $^{1}/_{8}$-in. thick aluminum. Welding is proceeding downhill.

The face-bend specimen of $^{1}/_{2}$-in. thick, 61W aluminum illustrated in Fig. 9, was welded with a single vee and a $^{1}/_{8}$-in. nose. The need for only a sealing bead on the reverse side shows the deep penetration possible.

An early example of Heliarc welding of aluminum without the use of flux was the construction of tanks to be used in mixing powder for the Navy. These tanks were constructed of 2S $^{1}/_{2}$ H aluminum sheets, $^{5}/_{32}$ in. thick. The tanks were made from three separate sheets. The first seams to be welded were clamped in a jig as shown in Fig. 10 and machine-welded at a speed of 8 in.

per minute. Upon completion of these seams, the inside of the tank was smoothed over with a light pass of the torch by hand.

In the construction of these tanks, the only cleaning consisted of a light rubbing of the edges with steel wool, before assembling in the jig. After the welding, no cleaning was required, and only the smallest amount of dressing of the welds produced the smooth surface required for these tanks.

A more recent application shows many improvements, including a welding speed of 16 in. per minute. The material is 61ST in an alloy previously considered difficult to weld. We refer in this case to the production of aluminum beer barrels. These are in the familiar $15^1/_2$ gallon size, which are constructed of two drawn halves joined by a girth seam. In Fig. 11 the fitting is being welded in one end of the barrel. Figure 12 shows the uniform smooth reinforcement attained on the inside of this fitting.

The next step is to join the two half shells in a welding jig, as shown in Fig. 13. The two small rollers which precede the welding torch have the important function of keeping the two edges of the seam exactly level. This is the operation mentioned previously which is carried on at the rate of 16 in. per minute. Heliarc welding provides a smooth joint with no crevices on the inside surface of the barrel to harbor bacteria. Welding on the

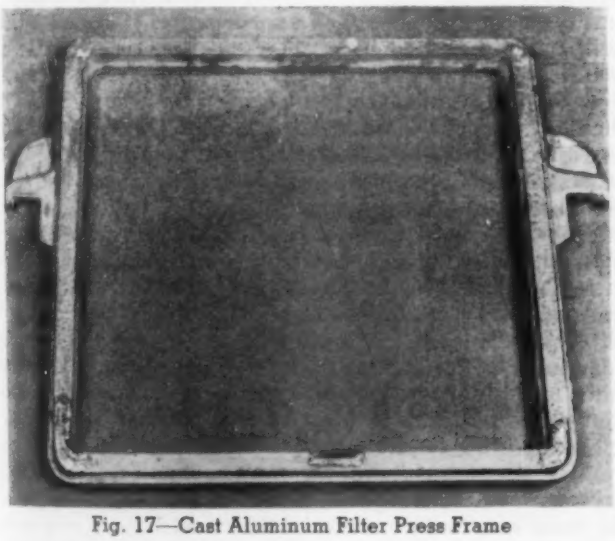


Fig. 17—Cast Aluminum Filter Press Frame

barrel is completed with the insertion of the bung plate. Figure 14 shows this bung-weld and the manner in which it is extended to complete the unwelded end of the girth seam. Before successful production was obtained, there were many difficult problems, including accurate forming of the parts to provide suitable fit-up for uniform welding conditions. In spite of the difficulties, however, it is generally agreed that this method is superior to the previously used gas-welding process.

Aluminum radar cases and components are another example of the widespread use of this process taking advantage of the lack of flux. One of these units is illustrated in Figs. 15 and 16, which also show the smooth surface obtained on corner welds in $^3/_{32}$-in. plates without polishing or after-treatment. This same manufacturer makes use of an ingenious variation of the plug weld to join partition-like assemblies which are built to such close tolerance that no distortion due to heat can be allowed. By this method, plates are joined which would otherwise require a fillet weld. Here again, the lack of flux eliminates the problem of cleaning between the abutting surfaces. In these particular items, the desired tolerances were so close that space had not been allowed for the conventional fillet weld.

Fig. 18—Stainless Steel Spout Parts

Aluminum Plate

Very recently fabrication was completed on several 14-ft. diam. tanks of $^3/_8$-in. thick 2S aluminum. Welds were made with one pass on each side at 400 amp. One seam was completed in $2^1/_2$ hr. as compared to approximately 11 hr. by the former method.

In another recently completed pressure-vessel project, several tanks, 10 ft. in diameter by 12 ft. in length with conical ends, were completely welded with the Heliarc process. In this case, the material was $^1/_4$ in. thick, the straight section of the tank was of 3S aluminum, and the conical end pieces were 61ST. All joints were of the butt type and were made on square edges. One pass from each side gave adequate penetration for complete fusion.

Here the major factor which led to the selection of the process was the lack of distortion. Preliminary tests had indicated that it would be possible to weld these vessels, after which they would need no straightening to overcome buckling produced by the heat effect.

Probably the largest scale Heliarc welding operations to date on aluminum have been in railway tank-car construction. These have three 40-ft. longitudinal seams between $^1/_2$- and $^5/_8$-in. thick plates. The circumferential seams on the ends join these to $^5/_8$-in. thick dished heads. The joint between the side plates and the dome involves a lap weld between $^1/_2$- and 1-in. thick plates. All of these welds, with the exception of the latter, are made without any preheating. The quietness, lack of smoke, sparks and spatter, and ease of operation of the method in contrast to metallic and carbon arc processes are large factors which have lead to its rapid acceptance for fabrication of heavy aluminum.

Fig. 19—Stainless Steel Spout Welding

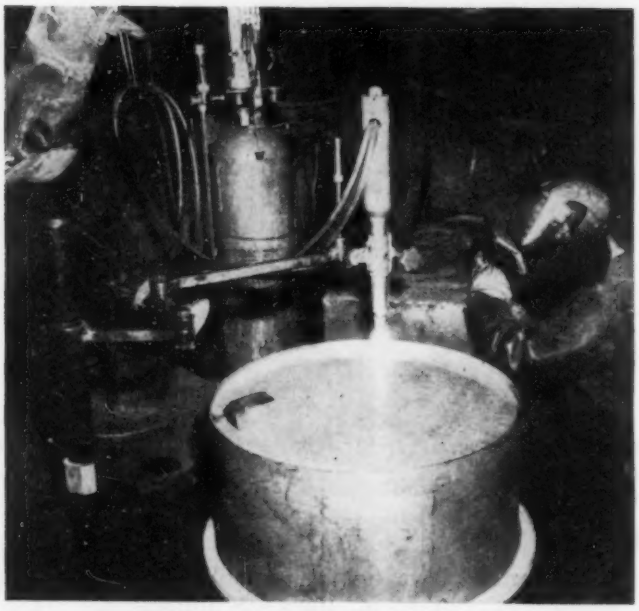


Fig. 20—Edge Weld on Stainless Steel Barrel

Cast Aluminum

As in the case of magnesium, the Heliarc welding process provides a convenient method of repairing defective aluminum castings. Figure 17 shows an aluminum filter press frame on which casting voids have been filled in with this method.

Stainless Steel

At present the Heliarc welding process is being employed in the fabrication of stainless steel types 302, 304, 316, 327, 347 and 410. This material is used in manufacturing milk processing equipment, food preparation equipment, chemical storage and reaction vessels, oil refinery equipment, barrels, aircraft exhaust manifolds, household and industrial kitchen ware, sinks and stoves. The outstanding advantage reported by the manufacturers is the remarkable saving in cleaning, grinding and repairing costs over other methods. Less obvious, but often more important, is the high quality of the weld in such aspects as no carbon increase, low heat effect and carbide precipitation, and extremely low non-metallic inclusions and porosity. Recent tests of weld metal for $^1/_2$-in. thick plates indicated no measurable loss of either nickel or chromium during welding.

Although there have been many outstanding applications of this process on stainless steel, two reasons have led to the belief that the adaptation of the process has been somewhat slow as compared to aluminum. In the first place, there are other methods of fusion welding stainless steel which are quite satisfactory. The difficulty of obtaining stainless steel materials has also had an influence. It is believed that when stock becomes more adequate, a great expansion in the use of these high-strength corrosion-resistant materials will take place. It is expected that along with this increased use, many new applications of this process will be made.

An early use of the process in the fabrication of stainless steel was the construction of spouts for cream separators. The steps used in the fabrication of these units are illustrated in Fig. 18. After cutting the two halves to size in the power shear, they were heated with an oxy-acetylene blowpipe and then shaped over a mandrel. They were then assembled, tacked and welded together as shown in Fig. 19. The parts were hand-finished to a high polish on power-grinding wheels. This application, as well as numerous others, shows that on stainless steel products welded by the Heliarc process, savings of from 40 to 75% can be made in the cost of post-weld cleaning and polishing operations as compared to those for metallic-arc welding.

Some very interesting savings were made in the application of the Heliarc process to the fabrication of stainless steel barrels shown in Fig. 20. The barrels are placed on a turntable and revolve under a stationary, adjustable torch. On a pilot-lot production of 16-gage barrels, it was found that the welding speed could be increased to approximately twice that of the former method, while at the same time rejections were decreased 80%. These welds were made at a rate of from 30 to 35 in. per minute, and with an argon cost of approximately 75 cents per hour. This cost was more than offset by the increase in welding speed and the decrease in rejections. In addition to this, a smoother and neater joint resulted. It should be noted here that, whereas the metallic-arc process required the addition of weld metal, the Heliarc process required no such metal since an edge joint was used, and the two edges needed only to be fused together.

Probably one of the most critical joining problems in the metal-working industry is encountered in the fabrication of vacuum-jacketed vessels used in the storage and transportation of liquefied gases, such as oxygen and nitrogen. Since the efficiency of these vessels depends upon maintaining an extremely high vacuum between the inner and outer shells, leakage rate of the joints is extremely important. Since ordinary pressure tests are not adequate to determine the presence of leakage, extremely accurate laboratory tests, sometimes requiring days or weeks to complete, must be made. In the past, the most satisfactory material for construction was copper. The sections of copper sheet were joined by soft-soldering. Although the strength of these joints was low, it was the only method by which the material could be joined, since silver-brazing could not be depended upon to produce a vacuum-type joint. Naturally, the physical strength of the soft-soldered joints was much less than desired, and failure frequently occurred due to

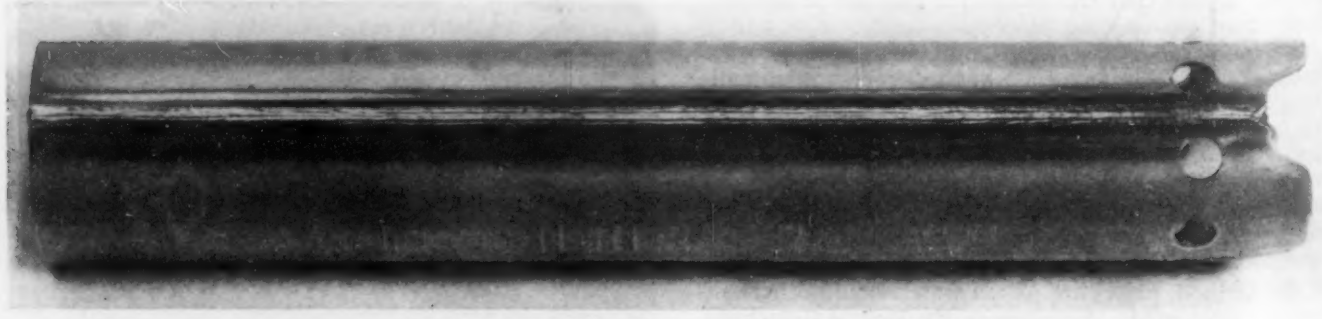


Fig. 21—Welded Tube with Punched Holes

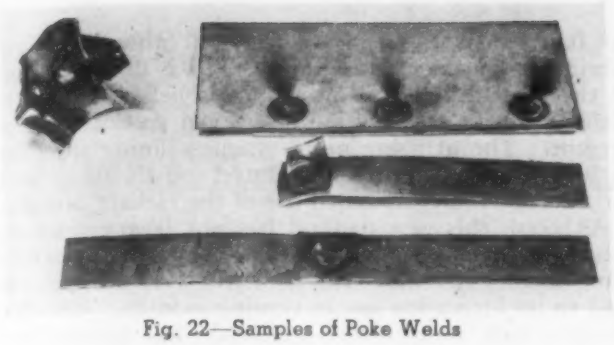


Fig. 22—Samples of Poke Welds

rough handling of the units. Before the introduction of Heliarc welding, a considerable amount of work was done, in attempting to fabricate these vessels from thinner gages of stainless steel. This was highly desirable as a stronger and lighter weight vessel could be expected if a suitable joint could be made. Despite all the efforts expanded, the highest quality of joints that could be obtained by any method was hopelessly inadequate on a porosity basis. Part of the difficulty was due to the sensitivity of other methods of welding to variations in the composition of the stainless steel. This problem has now been solved by the Heliarc process. Probably no better example of the soundness of these welds could be given.

The Heliarc process produced rather astounding savings in the manufacture of the stove part shown in Fig. 21. By this method, the tube could be fabricated from a sheet in which the holes were punched in a press; whereas in the previous method, these holes were drilled in a tube and the end was machined to the required shape. After the blanking operations, the sheet was formed into a tubular shape and placed in a jig for welding. The weld was then made at a rate of 40 in. per minute. In this manner the item could be produced for 27 cents less than by the previous method.

Similar savings have been effected through the use of Heliarc welding in the fabrication of other items that must be perforated or in tubular items of tapered shape, such as tapered spouts for teakettles and the sides of malted milk shake cans, both of which have been or are now in production.

Poke Welding

An interesting variation of the process that appears to have great utility is now being developed. This is the so-called Heliarc poke welding process. With a modified hand-welding torch and a weld timer, spot welds can be produced between lapped stainless steel sheets or between this material and the same or greater thickness of carbon steel. Aluminum sheets may also be joined in the same way. The spots in Fig. 22 are between $^3/_8$ and $^5/_8$ in. in diameter and have a strength about equivalent to electric resistance spot welds. The advantages over the latter method are low equipment cost, flexibility, portability, less rigid cleaning requirements, and less restriction on size and shape of parts to be joined. The length of time (average four seconds) to complete one spot is longer than for resistance welding, and the cost per spot may be somewhat higher. It may, however, be used on many types of construction such as box-car and tank lining where resistance welding is not applicable. The process has been used in making steam jacketed, stainless steel

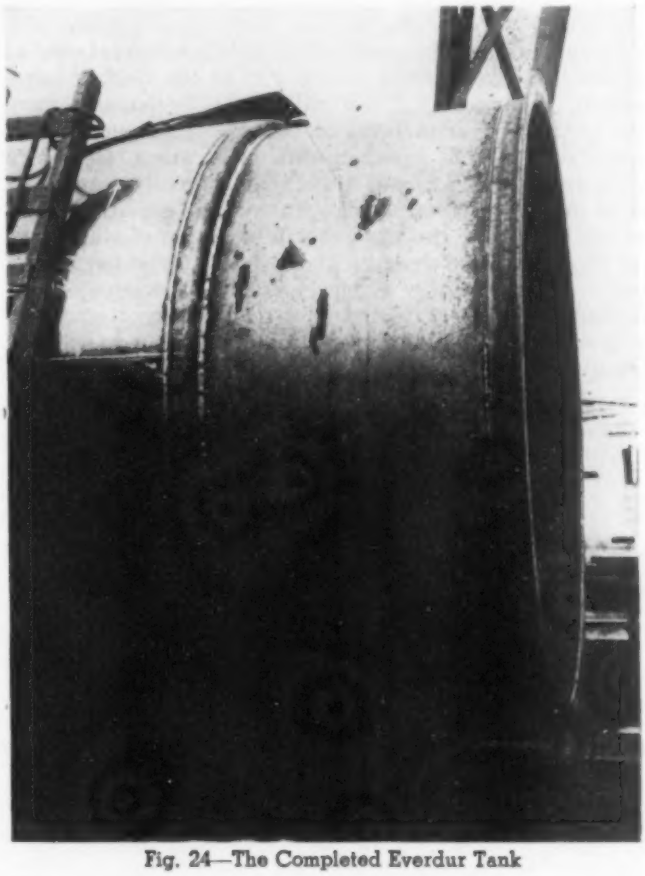


Fig. 24—The Completed Everdur Tank

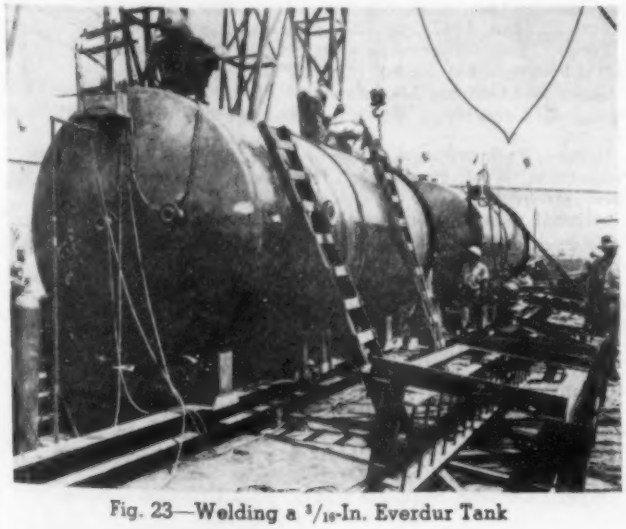


Fig. 23—Welding a $^3/_{16}$-In. Everdur Tank

vessels where the corrosion resistant shells were attached to carbon steel spacer bars. Since the weld is made from the 16-gage stainless steel side, very little fusion of the $^1/_2$-in. square carbon steel spacer bars occurs. Corrosion tests of the joints indicate adequate resistance.

Other Materials

Although the major use of the process has been on the three materials discussed previously, it is by no means limited in its application to these materials. Important use of the process has been made on difficult manufacturing operations involving pure silver, Monel, Everdur, Inconel, and various copper and nickel alloys. A use which is gaining rapidly in popularity is the fabrication of large chemical storage tanks made of Everdur. In Fig. 23 the welding procedure is shown in progress of 18-ft. long, 8-ft. diam. Everdur tanks. The shell thickness is $^3/_{16}$-in. and the heads are $^1/_4$ in. thick. Attached to one end of the tank is a 3-ft. steel skirt. The joint between the tank and the skirt, shown in Fig. 24, is also

made with an Everdur rod and the Heliarc process. This type of welding is carried on by using $^3/_{16}$-in. and $^1/_4$-in. tungsten electrodes with alternating current. In this case, two welders work simultaneously on vessels, each applying one bead on the inside and outside with welding rods. A back-up bar is used on the shell to head seam and the joint is completed with welding rod in two passes from the outside. The clean appearance of the finished vessel shows the lack of weld spatter.

In another plant, similar production of $^1/_4$-in. Everdur seams is carried on using direct current, straight polarity, and $^1/_8$-in. electrodes. This current gives a narrower bead than alternating current.

Conclusion

In considering the future of this process, a great deal of expansion seems certain to occur. In the field of magnesium, this increased use will probably parallel very closely the rate of increase in the use of magnesium alloys. In the field of aluminum fabrication, there are estimates made that enormous expansion will occur in the use of the material itself. It seems almost inevitable that use of the Heliarc process in the fabrication of aluminum will increase at an even greater rate than the use of the material, due to the displacement of previously used methods of welding. The use of the process on stainless steel welding will no doubt increase somewhat in proportion to the increased use of material itself. Whether or not it will displace to any great extent other methods of fabrication on thicknesses above $^1/_4$ in. is difficult to say at the present time. However, it is believed that the Heliarc process will be used on heavier sections than at present. The attachment of stainless lining sheets to carbon steel shells will be facilitated and should account for a considerably expanded use of the Heliarc process.

Although this new method has not been extensively used in welding the copper and nickel alloys, it does offer some distinct advantages in quality of weld which should lead to its increasing use in coming months. The field of ultra-high temperature materials has hardly been touched. Experimental work to date indicates that many of these alloys can be welded by the method. In addition, there are several other interesting applications which, to date, have not been used because of the lack of a suitable method of operation. Particular reference is made to such procedures as the deposition of high-silver alloys on aluminum surfaces and of pure silver on various backing materials to obtain highly corrosion resistant surfaces. The field of hard-surfacing has hardly been scratched. Considerable work has been done, and yet more remains to be done. It is, however, evident that as compared to the oxyacetylene method, the Heliarc process will produce important increases in rate of application. At the same time, greater hardness will probably be obtained in most of these alloys than is possible when applied with the metallic arc method. When these processes are properly evaluated, it seems quite possible that an important place in this field will be found for the new Heliarc process.

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Oxygen Cutting, Stainless Steel. Flux-Injection Cutting Stain-

(*Continued on page 425*)

Automatic Oxyacetylene Operations*

By R. F. Helmkamp†

AN inventory of progress in the application of gas cutting to industrial production problems reveals that World War I developed the process to a jittery possibility of severing thicknesses which are routine today.

The initial application of gas cutting to the problem of straight lines and circles and combinations of the two, in the lighter plate thicknesses, has helped make some of our World War II industrialists famous for their accomplishments. We read all about their over-all astounding production records, but the details, the process used and the know-how, that were the reasons for much of this, have been submerged. In many cases gas cutting played an important part.

There are always those individuals and groups whom the pioneering spirit goads to investigate the unknown. This spirit of conquest has paid dividends for the energy extended. The serious effort and the vision behind the planning develop the accomplishment to a point where an orderly set of rules makes it possible for others to use the development to advantage.

The present era might be briefly described as one of miserable prosperity. Industry as a result is on a treadmill trying to produce, to be competitive as to price, to uphold quality, to deliver in a reasonable length of time and above all to stay in business. As ever in times like these, various processes are carefully investigated to determine the one that is most economical for a given job.

With reconversion plans borrowing heavily from war-proved practices, many of the current problems of metal severing are being solved by applying gas cutting principles and procedures. In the field of heavy cutting and hot cutting, we have progressed to a point where it is reasonably possible to calculate a setup of equipment and procedure that should at least produce usable results. It is hard to fix the limit of thickness of material that can be gas cut, since such a limit has not been reached.

Now that gas cutting has proved its worth in production lines, meeting many requirements as to accuracy and speed, the demand is for semiautomatic, fully automatic and remote controls. Much existing production equipment plans the incorporation of gas cutting equipment. New planning has the advantage of not being hampered with existing equipment and can therefore plan without these restrictions.

In this era of rising prices oxygen is a product with unusual economic potentialities. Its widespread field of uses, other than cutting, and the low capital investment of the equipment to apply it makes its possibilities very attractive in production schemes.

While up to the present most gas cutting has been done in a flat position, that does not mean that the process may not be applied in other planes and combinations of planes. We are at present emerging into the field so aptly covered by the complex and highly specialized machine tool. With no tool thrust to contend with, and the torch and tips generally the only moving parts, the equipment is usually much lighter, powered with lighter motors and generally less expensive.

When a process holds the promise of greater production results from its application to existing equipment, it is readily understood why gas cutting meets with such favor in steel mills. Hot cutting in the roll mill cycle, in many cases, is now practical. We find mills cropping ingots, blooms, and billets, cutting billets, slabs and blooms into multiple lengths and final lengths. While such operations are speedy, further production advantages are gained by synchronous multiple torch operations. The over-all time cycle for multiple cuts need be no more than the time required for a single cut. If there is time for a single cut, there is time for multiple cuts.

Advances, through research in equipment, have provided gas supply and regulating equipment capable of higher speeds and meeting the requirements as to thickness. Such equipment is here, it is available and ready to use. Much of the steel mill requirement is for gas cutting at elevated or rolling temperatures. Fortunately, the general factors of gas cutting at elevated temperatures conform to the same general principles as cold cutting. Cutting speeds increase with the heat of the material in the order of 2 to 3 times the normal speeds for cold material. This speed increase is somewhat gradual until we reach a temperature slightly above the critieal at which point the present maximum speeds are reached. For the present existing mill speeds many gas cutting applications are practical.

Alloy steels and heavy sections should be gas cut while hot for proved metallurgical reasons. The hot cutting of alloys, fitted into production lines, in many cases eliminates other time and cost factors such as handling and

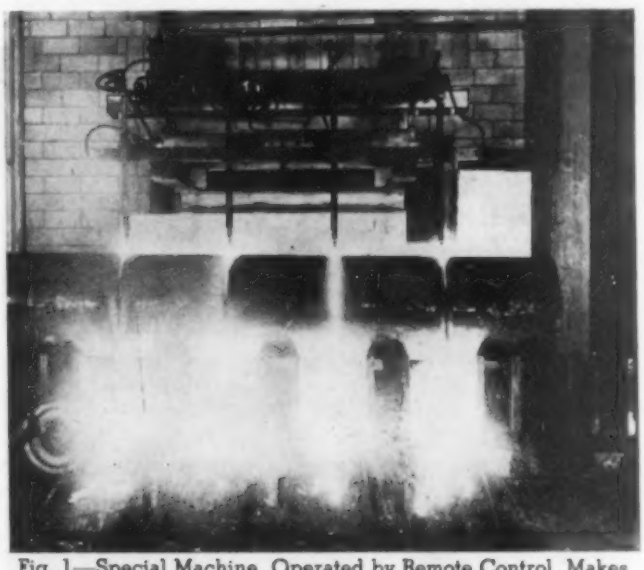


Fig. 1—Special Machine, Operated by Remote Control, Makes Four Simultaneous Cuts in a 60-Ton Alloy Round. Torches and Support Members in the Heat Zone Are Water-Cooled and Special Cast-Iron Supports Hold the Sections Steady When the Cut Is Completed

* Presented at Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., week of Nov. 17, 1946.

† Machine Cutting Specialist, Air Reduction Sales Co.

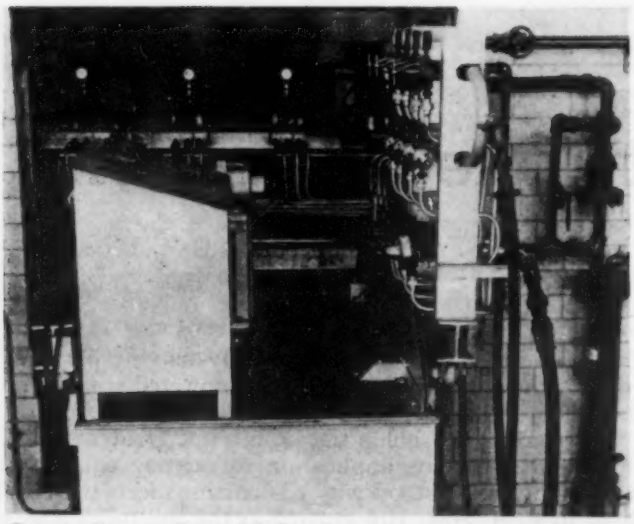


Fig. 2—Remote Control Pulpit for Machine Shown in Fig. 1, Providing Both Selective and Collective Control of the Four Torches on the Machine

processing at another point. Such planning helps to lower the unit cost.

Forge shops are now cutting forging slugs, both large and small. Hourly press and hammer costs are high, by comparison to the torch, for trimming or cropping forgings. Such work done at forging heat with suitable gas cutting equipment is a process working satisfactorily and worth consideration where not now employed.

In Fig. 1 we have a 60-ton alloy ingot that has been forged into a 28-in. diameter round from which forging slugs are being cut to definite lengths. This material is brought to the cutting bed directly after forging and cut to length immediately.

The cutting bed consists of a special car with cast-iron slag pans and individual adjustable vee supports, positioned to hold the severed pieces from movement after the completion of the cut.

This special machine is equipped with water-cooled torches and support members in the heat zone. A remote control arrangement is operated from behind a fire brick wall (Fig. 2). The input oxygen and acetylene lines are connected by rubber hose lines to the reciprocating members of the machine. Individual gas control regulators are piped to the solenoid valve controls for the individual torches. Each torch is equipped with a pressure gage for reading torch entry cutting oxygen pressure. Three-position electric switches control the individual torches, and a master switch may control all torches in unison. By such an arrangement selective or collective control is available as required.

The cropping of ingots, blooms, billets, slabs, etc., and cutting such sections to length for mill and customer requirements are processes being woven into production lines. Figure 3 shows the cropping of both ends of a 32-in. diameter corrugated ingot. While both ends are being cut at the same time, they are of different diameters. The hot top is cut off in the 32 in. diameter, and the stool cross section is 20 in. in diameter, yet both are cut simultaneously.

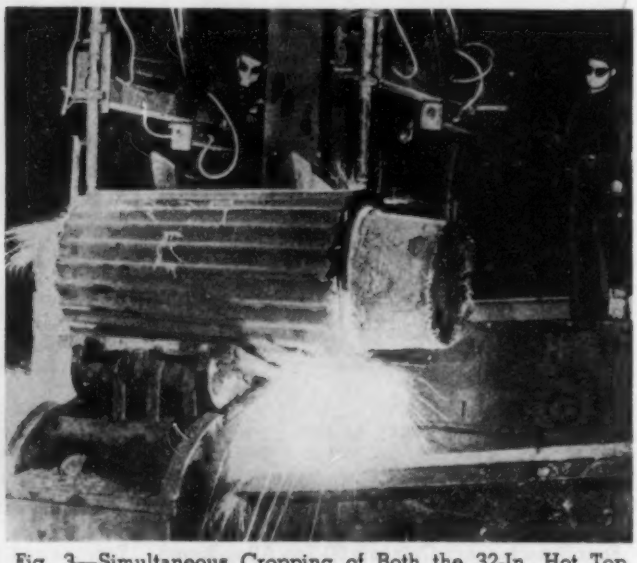


Fig. 3—Simultaneous Cropping of Both the 32-In. Hot Top and 20-In. Stool Cross Section of a 32-In. Diameter Corrugated Ingot

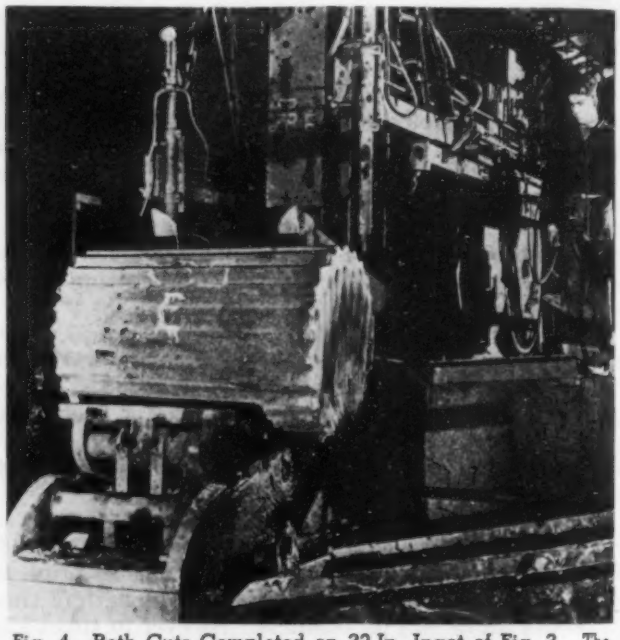


Fig. 4—Both Cuts Completed on 32-In. Ingot of Fig. 3. The Cropping Operation Was Fitted into Mill Production Lines, One Machine Handling Production of 900 Pieces per Month

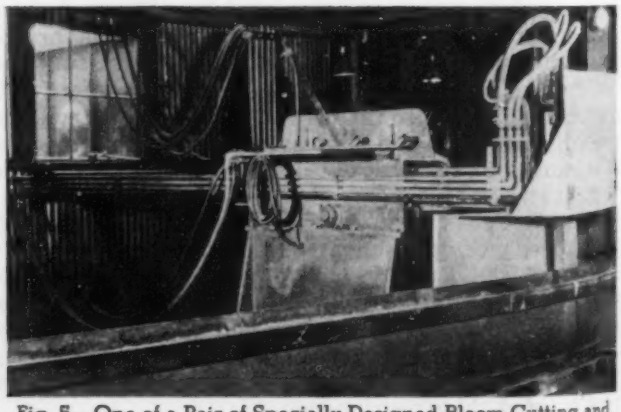


Fig. 5—One of a Pair of Specially Designed Bloom Cutting and Cropping Machines, Equipped with Controls for Raising, Lowering and Angular Adjustments. These and All Other Gas and Electric Controls Are Centralized at the Operator's Shielded Station

In Fig. 4 both cuts have been completed. The production of this item was 900 pieces per month, and one machine handled all production.

Figure 5 shows a pair of specially designed bloom cutting and cropping machines in action. Since the material is alloy, the cutting is done while hot, and the torch and machine members in the heat zone are water cooled.

The bloom cutting machines are mounted on rails for longitudinal positioning (Fig. 6). The machines and operators are protected with a suitable barricade. Controls

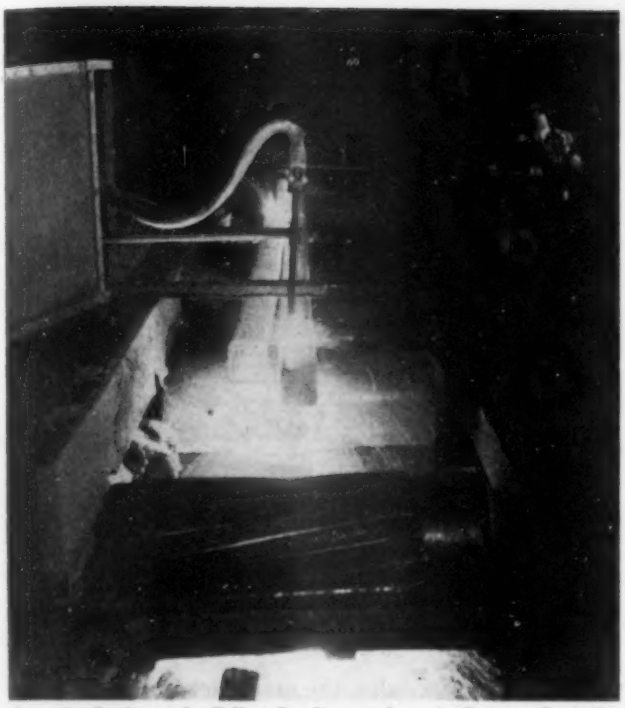


Fig. 6—A 6- x 6- Billet Is Cropped and Cut to Length, Within the Roll Mill Cycle of One per Minute. The Steel Is at 1700–1800° and Is Cut in 15–18 Sec.

are provided for raising, lowering and angular adjustments. All gas and electric controls are centralized at the operators station.

The operation in Fig. 7 is the cropping and cutting to length of a 6- x 6-in. billet on the roll line within the roll mill cycle of one billet per minute. The material is at a temperature ranging from 1700 to 1800° F. when cut, and the severing cuts were made in from 15 to 18 sec. Two machines kept up with the mill. Protective barricades for the operators and the machines consist of copper screen which provides adequate heat protection without impairing visibility.

When special attention is given to better control of gas cutting operations, we find that the process uncovers some hidden values. In one case (Fig. 8) the initial gas cutting operation on carbine mouthpieces eliminated several broaching operations. The alloy bar material

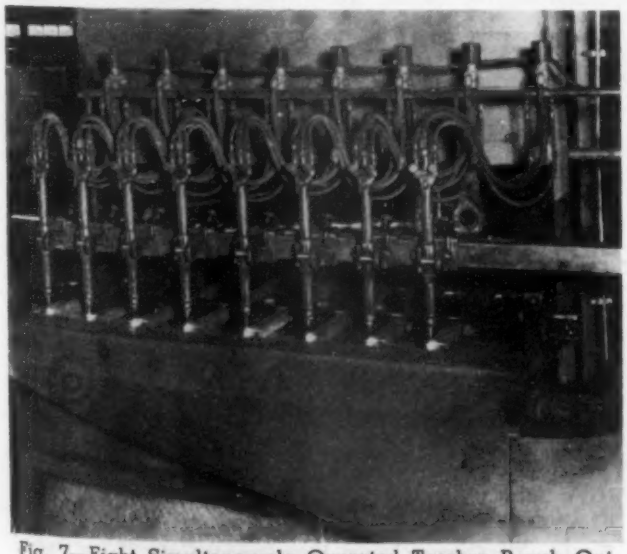


Fig. 7—Eight Simultaneously Operated Torches Rough Out Carbine Mouthpieces from Alloy Bar Stock, Eliminating Several Broaching Operations

Fig. 8—The Cuts (Fig. 7) Are Made by a Highly Specialized Cutting Unit, Equipped with Individual Torch Solenoid Oxygen Shut-Off Valves. The Machine Is Remote Controlled and Guided by a Magnetic Tracing Device

was fed into the cutting area by gravity, clamped and cut. The pieces received heat treatment immediately after cutting and were then on their way to be machined.

The individual solenoid controls provided a quick shut-off of cutting oxygen, overcoming a detrimental condition existing without their use. Figure 9 is an over-all view of this highly specialized 8-torch gas cutting unit which is remotely controlled and operating with a magnetic tracing device.

Fig. 9—The Electronic Tracer—or "Electronic Bloodhound"—Automatically Follows the Outline of a Black and White Paper Template, Producing an Accurate Duplicate of the Drawing Without External Guidance

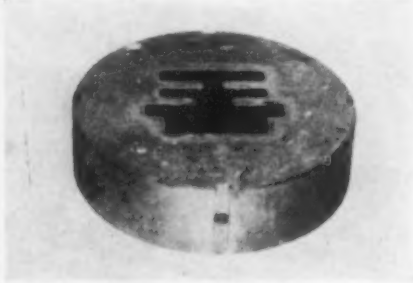


Fig. 10—This Die-Backer, Flame Cut from 5-In. Material, Demonstrates the Ability of the Electronic Tracer to Produce Slender "Fingers" and Narrow Slots, Difficult or Impossible to Obtain with Ordinary Tracing Means

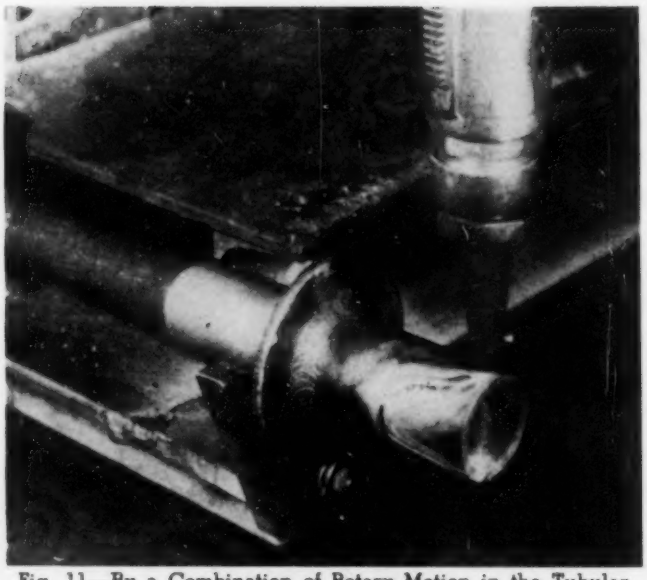


Fig. 11—By a Combination of Rotary Motion in the Tubular Work Piece and Linear Motion in the Torch, Intricately Shaped Cuts Are Made in the Ends of Aircraft Axles

The electronic tracing device (Fig. 10) is a scanning mechanism for shape-cutting machines that faithfully reproduces the pattern of a black and white paper template automatically and with great accuracy, even to such intricate shapes as a complex die backer (Fig. 11) gas cut from material 5 in. in thickness. The alloy steel was preheated for cutting, and the accuracy of the electronic tracer rendered a faithful reproduction of the template.

Among special production applications of gas cutting is the shaping of airplane landing wheel axles (Fig. 12). The hollow axles are held in position by a chuck and revolved under the cutting torch by the magnetic tracer, guided by a circular cam which also moves the torch to produce the desired contour.

With the work held in position and revolved at the proper cutting speed (Fig. 13) the torch merely has to progress in one direction which is in line with the work piece. A fixed bracket equipped with guide rollers holds the operating torch bar in the required position.

The production requirements for these axles could not be met with available machine tools but were readily satisfied with this gas cutting arrangement. Besides meeting production schedules, the manufacturing cost was reduced to approximately one third of previous figures.

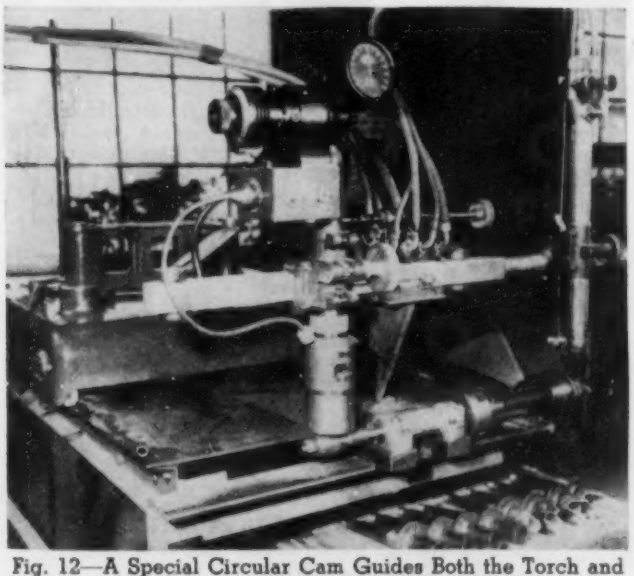


Fig. 12—A Special Circular Cam Guides Both the Torch and the Workpiece to Produce the Multiple Curves in a Circular Piece (Fig. 11). This Setup Made Possible Production Schedules Which Could Be Met in No Other Way

Fig. 13—This 50-In. Riser, on a 50-Ton Casting Was Cut Off in 22 Min., with a Heavy-Duty Portable Machine. A Second Cut 1 In. from the Finish Line Saved Considerable Machining

While the gas cutting of risers in steel foundries is standard practice, there are times when a special problem presents itself (Fig. 14). In this case a 50-ton casting had a riser 52 in. in diameter. The riser was first cut 4 in. above the finish line and removed. A second cut was made 1 in. above the finish line, eliminating considerable machining. The cut was made with a heavy duty portable machine in 22 min., using 2300 cu. ft. of oxygen.

Heavy scrap is desirable but generally hard to obtain in sufficient volume, yet mills in the past have buried large unwieldy pieces. Now many mills are mining heavy scrap on their property and reducing it to charging-box size. This can be done with the oxygen lance alone or speeded up when using a torch in conjunction with the lance. With some simple facilities, machine gas cutting further reduces the cost and increases the tonnage.

The lance alone is capable of severing extremely large sections. In Fig. 15 a 75-ton open hearth spill is being cut to handling size for removal with the oxygen lance doing the entire job. The section is approximately 5 x 10 x 15 ft.

Each sizable chunk was further reduced to charging

Fig. 14—The Oxygen Lance, Here Used to Cut a 75-Ton Open-Hearth Spill to Handling Size, Is Capable of Severing Extremely Heavy Sections

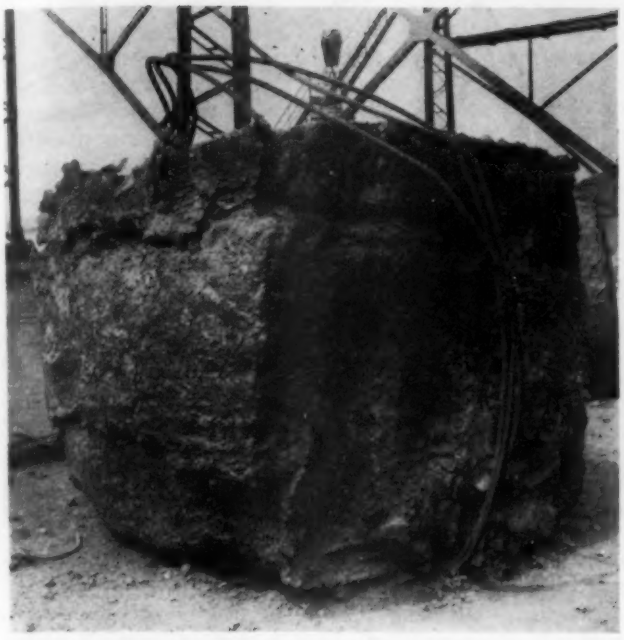


Fig. 15—Each Large Chunk of the 75-Ton Spill (Fig. 14) Was Further Reduced to Charging Box Size with the Lance. The Original Spill Measured About 5 x 10 x 15 Ft.

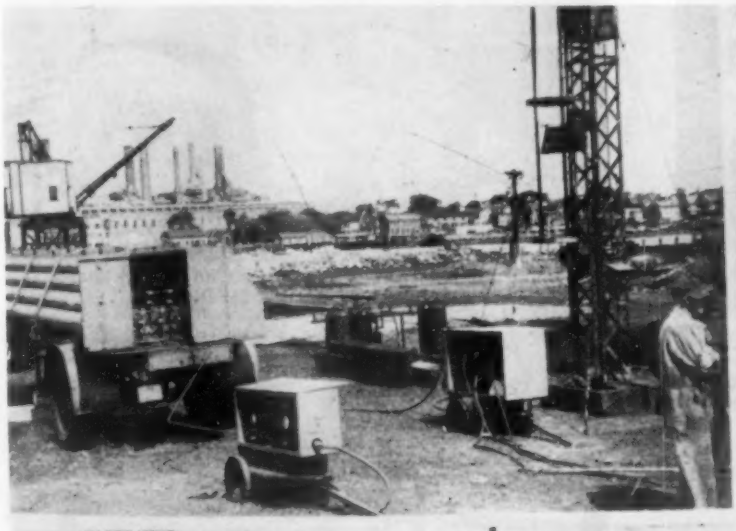
box size (Fig. 16) with the lance. The appearance of the oxygen lanced surface is visible underneath the cable sling.

Heavy scrapping projects are often located in areas beyond existing pipe lines. Since the gas volume required is considerable, it has been found economical and practical to locate oxygen trailers (Fig. 17) in such areas to provide for a continuous operation. In order to use oxygen trailers on projects of this type, it is necessary to have a regulator (Fig. 18) of sufficient capacity for the combined requirements of all operations. This large capacity high-pressure oxygen regulator is fitted at the high-pressure inlet with a rigid connection, the low pressure side discharges into a rubber hose line. Both the high and low pressure sides of the regulator are equipped with pressure gages.

Acetylene requirements are furnished by a portable manifold. The oxygen and acetylene are supplied to a portable distributing manifold (Fig. 19) which serves the torches and lances. The connection is by a large diameter rubber hose which allows extreme flexibility in the loca-

Fig. 16—An Oxygen Trailer Set Up for Heavy Scrapping Operations in a Location Beyond the Reach of Pipe Lines, Makes Possible Economic Reclaiming of Otherwise Useless Heavy Scrap

Fig. 18—Portable Heavy-Duty Manifold for Field Scrapping Operations, in Conjunction with an Oxygen Trailer, Serves Several Torches or Lances, Permitting Flexible and Efficient Operations



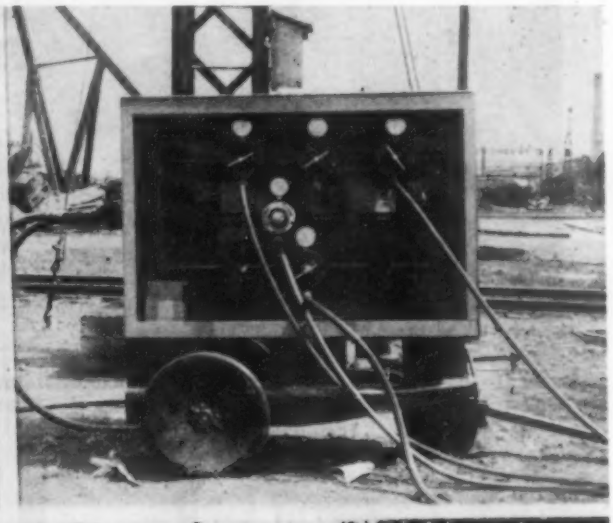


Fig. 17—Portable, Large-Capacity Heavy-Duty Regulator, Used with Oxygen Trailer for Field Scrapping Operations, Is Equipped with Pressure Gages on Both High and Low Pressure Sides

Fig. 19—Use of a Heavy-Duty Hand Torch in Conjunction with the Lance Permits Severing Heavy Sections Where They Lie in Any Position, Without Handling, as Well as a Higher Rate of Production

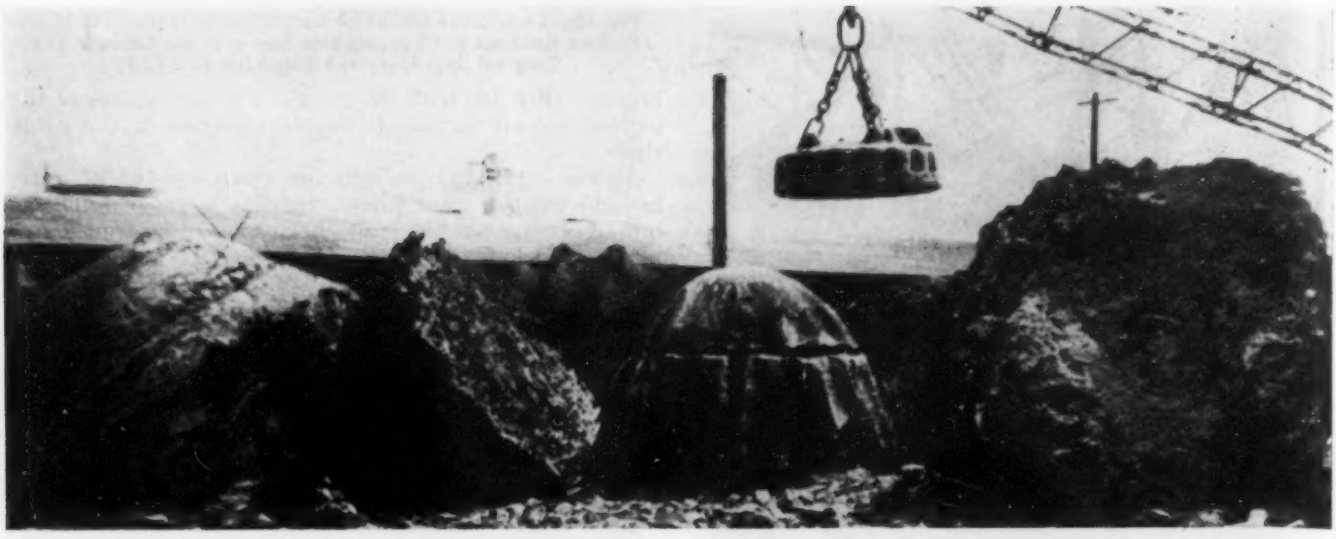


Fig. 20—Typical View of Heavy Scrap, Skulls and Buttons, Reduced to Charging Box Size with the Aid of Heavy-Duty Torches and the Lance

Fig. 21—Badly Needed Heavy Scrap, Reduced to Charging Box Size by Gas Cutting, Is Ready for the Furnace at a Minimum Cost for Reclamation

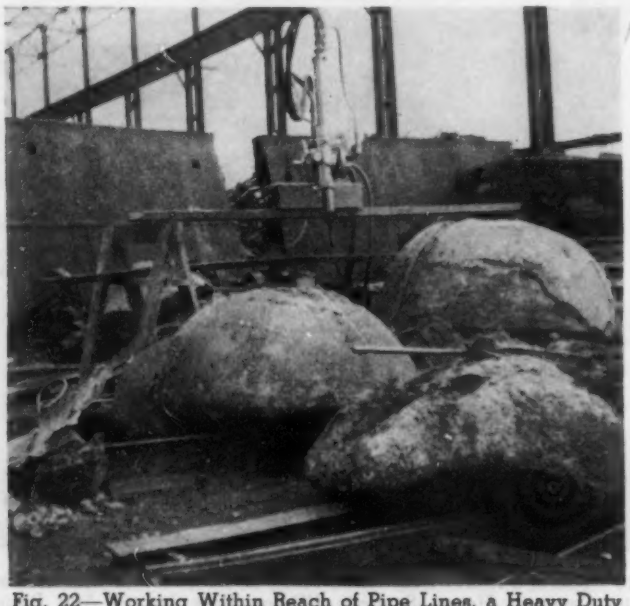


Fig. 22—Working Within Reach of Pipe Lines, a Heavy Duty Torch Mounted on a Heavy Duty Portable Cutting Machine Can Be Used for Many Scrapping Operations

Fig. 23—The Heavy Machine Torch Is the Most Productive of Scrapping Methods When the Scrap Can Be Positioned, and the Machine Set Up, for Its Use

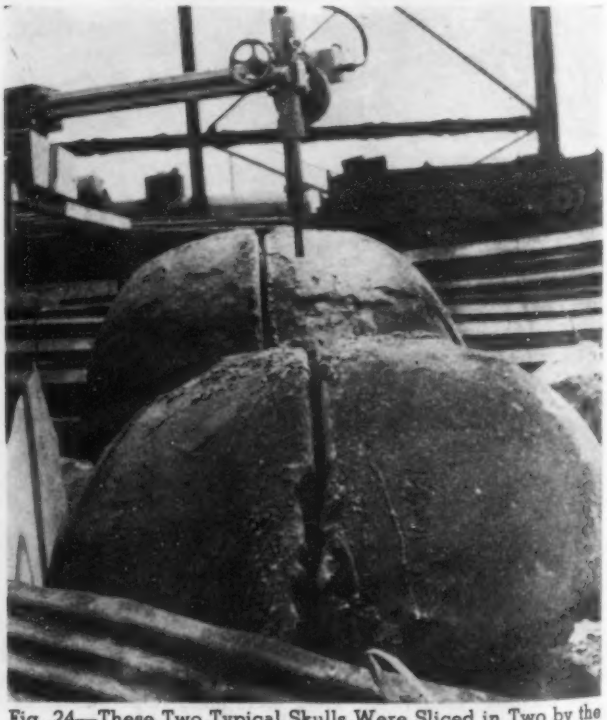


Fig. 24—These Two Typical Skulls Were Sliced in Two by the Heavy Duty Machine Torch in About 45 Minutes Each

tion of the portable manifold. Hose lines from the regulators on the portable manifold serve the torches and lance valves as in ordinary operations.

Often many large sections to be scrapped are found lying where they were dumped. One of the advantages of using the heavy duty hand torch with a lance (Fig. 19) is that work may progress efficiently without initial handling since the chunks may be cut to required sizes in any position. The hand torch cuts part way and maintains the hot spot for continuous lancing operations. Figures 20 and 21 illustrate typical scrapping results.

The third and most productive method of heavy scrapping is accomplished by the use of a machine. A setup using a heavy duty cutting torch on a heavy duty portable gas cutting machine (Figs. 22 and 23) has been used with good results to cut up heavy skulls. Figure 24 shows the heavy duty torch in position, and the two cut pieces in line with the path of the torch. These cuts were each made in approximately 45 min.

Of the three methods used, the lance alone represents the original, and still valuable, economy in such operations, while the lance-torch combination offers even greater efficiency and economy, and the heavy duty machine scrapping setup easily outdoes both the hand methods in economy and tonnage produced. Each method, of course, has its peculiar advantages—and limitations—which make final choice a matter of fitting the tool to the job, but practically any heavy scrapping operation is within the scope of one of the three.

Conclusion

Many of the answers to present problems may be had with the proper use of oxygen and the necessary equipment, the development of which has kept pace with present needs.

The electronic tracer has simplified the making of templates and reduced their cost; it has improved accuracy and minimized the human element.

The stainless steel cutting process is giving the mill, the scrap dealer and the processer a coveted advantage, thereby opening a greater field for the outlet of stainless products.

The forge shop, with the aid of the torch, may step up production with existing forging equipment.

Specialized applications, in many cases, only await inquiry and enough production volume to put them to work.

The mills can do things that may have been but dreams. Cutting operations within the mill cycle, remotely or fully automatic as to controls, make this possible.

Scrapping of heavy sections, hitherto not practical, is now possible and economical.

(*Continued from page 418*)

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Three-Phase Balanced Load Resistance Welding Machines*

By J. L. Solomon†

THE operation of resistance welding equipment has always presented a serious power problem from the viewpoint of the Public Service Co. supplying power to the user of this equipment. This has been due to the fact that the ordinary single-phase welder operates at low power factor, usually below 30%, and has a high kva. demand for relatively short periods of time. This single-phase load on the usual three-phase supply system produces unbalanced conditions in the three-phase supply with the resulting disturbances in the voltage conditions on the three phases. Furthermore, in those installations in which synchronous control is not used, transient currents reaching peak values up to two times the steady state peak currents may be drawn at the start of each weld impulse.

Another factor in the operation of single-phase welding equipment is that as the material being welded is introduced into the throat of the machine the current passing through the secondary circuit decreases due to the increased secondary throat impedance, thus causing decreasing of the heat in the weld and consequently decreasing weld strength with each further movement of the work into the throat of the machine. This necessitates the installation of current compensating devices whose function is the maintenance of constant current in the secondary of the welding machine, thus increasing the cost of the original investment.

In alternating currents, moreover, it is a well-known fact that the a.-c. resistance is increased above the value of the d.-c. resistance due to the phenomena known as skin effect, the current flowing near the surface of the conductor—the depth of penetration decreasing with an increase in frequency. From the many tests conducted on welding apparatus it has been found that the ratio of the a.-c. resistance to the d.-c. resistance is in the neighborhood of 2.3 at a frequency of 60 cycles per second.

Another point to keep in mind is that during each half cycle of the 60-cycle current, heat is developed in proportion to the square of the current, and if we draw a graph of current squared we can readily see that the curve rises rather sharply, indicating production of heat in the weld, reaches a maximum and then starts dropping off with consequent dropping off in the production of heat. This means that for each half cycle there is a period during which the welded area is heated and then allowed to cool slightly. During each half cycle there is a production of heat, after which the production of heat drops off and the heat is allowed to dissipate in the material which is being welded. These blank spaces in the heating curve indicate that a much higher peak value of current is required when using this type of a wave than if we would weld with a continuous current. Although one might say the definition of the R.M.S. current of a sinusoidal wave takes into consideration the actual heating effect of the total wave, we must remember that this definition is based upon the fact that the heat that is produced by each type of current is not allowed to dissipate into the surrounding medium. In practical applications where the heat as it is produced is allowed to dissipate we must take into consideration the fact that our peak currents will have to be much higher than is indicated by the ratio of R.M.S. to the peak value. With a wave shape of current as in Figs. 2 and 3, the production of heat (I^2RT) during the weld is steady since there is no removal of the load during the impulse, and as a consequence, no loss of heat. The peak current, therefore, does not have to reach as high a value as the R.M.S. of an a.-c. wave to produce the same heating effect in the same time.

A number of systems have been devised with the object in mind of reducing the kva. demand on the power supply, and improving the power factor.

One of these systems makes use of a motor generator set with a large flywheel on the shaft so that there is a great deal of energy storage which tends to soften the kick of the welder load on the line. The motor is a high slip type operating from the three-phase line. The generator may be wound for low frequencies so as to take advantage of the lower secondary impedance and resulting lowered demand of a welder operating at low frequencies. Systems of this type, where the generator delivered power to a welder at frequencies of $16^2/_3$ cycles per second, were successfully installed in France. This system has one great disadvantage, namely, the initial cost is very high.

Another system in popular use is the installation of series capacitor power factor correction equipment. The welding load may be power factor corrected by the installation of series capacitors so that the system operates at near unity power factor instead of around 30%, thereby reducing the kva. demand in proportion. In this system the use of additional equipment, in the form of a bank of series capacitors, auto transformer, high-voltage synchronous control equipment, discharge resistor to discharge the series capacitors, over-voltage protective equipment and cabinets for housing, adds to the original cost. A welding transformer wound for the nominal line voltage may be used in conjunction with an auto transformer, or the welding transformer may be wound for the high voltage required by the use of series capacitors. The voltage, in the case of welding transformers having a power factor of 25%, would be around 1800, in the event that the power supply was 460 v. The total cost of installing series capacitor correction equipment also runs rather high, since the cost of capacitors alone will be at least $4.00 per uncorrected kva. The additional equipment required—that is, an auto transformer, high voltage synchronous timer and contactor, discharge resistors, and high voltage protective

* Presented at Twenty-Seventh Annual Meeting, A.W.S., Atlantic City, N. J., week of Nov. 17, 1946.
† Sciaky Bros., Chicago, Ill.

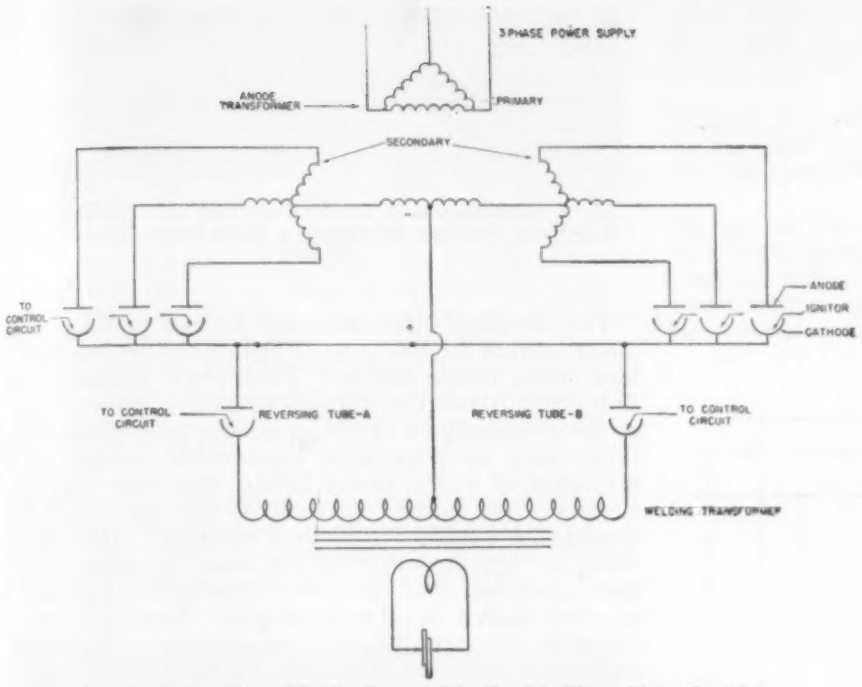


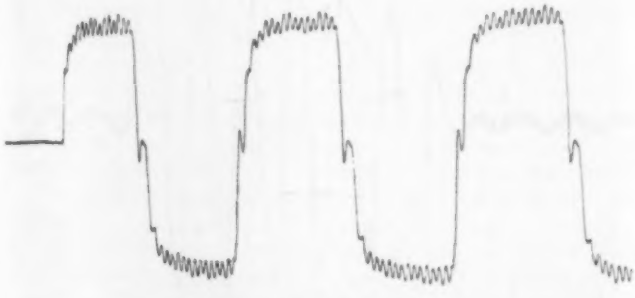
Fig. 1—Three-Phase Welder Powered by Double Three-Phase Rectifier

equipment—would increase the cost of the complete installation for a machine having a peak demand of 500 kva. with a power factor of 25%, by approximately $4800. Furthermore, after the correction is realized, the demand is still on a single phase, thereby unbalancing the three-phase system. Another disadvantage is that extreme safety precautions must be observed in the installation and operation of a machine of this type since the voltage across the primary of the welding transformer and across the series capacitors may run as high as 1800 v.

The stored energy type of apparatus allows the use of direct current for performing the welding operation, and the rectifiers used in this type of equipment can be very readily made to operate from a three-phase power supply. This type of equipment is entirely satisfactory for the welding of aluminum and other materials requiring high peak currents of short duration, but is not very satisfactory for the welding of steel.

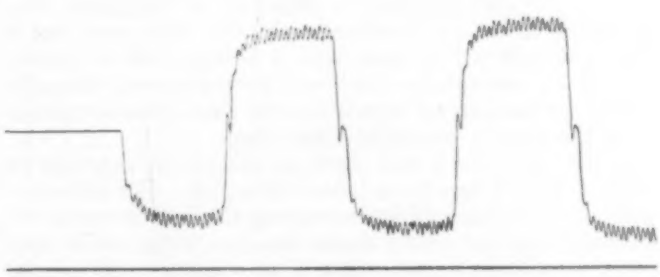
In order to perform a given welding operation upon steel with a minimum requirement in power, and in order to allow the three-phase system to be used to better advantage, the system known as the three-phase single-phase system has been developed. In this type of welding apparatus the three-phase power supply feeds a rectifier which supplies direct current to a welding transformer. The controls for the system may be either mechanical or fully electronic, depending upon the application of the machine. Figure 1 represents a system of this type. Electron current from the rectifier, in this case a double three-phase six-tube rectifier, is allowed to pass in one direction through the welding transformer, from the negative through one of the reversing ignitron tubes, *A*, which is made conductive, and back to the positive of the rectifier. A control circuit is so arranged that it allows the rectifier to fire through the welding transformer and one of the reversing tubes for a period of time which may be preset from one to ten cycles of the 60-cycle line. After this initial period, all tubes in the rectifier are made nonconductive, and immediately thereafter made conductive again except that current is allowed to flow through the second half of the welding transformer since the second reversing tube is now made conductive. During each impulse of "on" time the current in the primary rises exponentially, its shape depending upon the parameters of the welding circuit. The resulting changes in field in the iron core induces a voltage in the secondary which in turn forces the welding current through the secondary circuit and the material to be welded. The shape of the secondary current will, therefore, be as indicated in Figs. 2 and 3. It starts at zero, rises exponentially, and after 0.02 seconds continues for the "on" time period as a direct current with little change in intensity, drops to zero and then reverses its direction and rises again in the opposite direction following the same shape of current wave it did previously, thus forming a complete cycle which in a way represents a single-phase current of low frequency. The frequency in the secondary can be varied at will by increasing the length of the "on" time pulse; for instance, if the "on" time pulse is one cycle, the frequency in the secondary circuit will be 30 cycles per second. If the "on" time pulse is 10 cycles, the frequency in the secondary circuit will be three cycles per second.

Another form of a three-phase welder is illustrated in Fig. 4. This type of apparatus eliminates the use of a separate rectifier in that both the rectification action and transformation action are realized on one iron core



Oscillogram of Secondary Current
3 Phase Welder
Frequency 5 Cycles Per Second
Fig. 2

Fig. 2—Oscillogram of Secondary Current, Three-Phase Welder, Frequency 5 Cycles per Second



Oscillogram of Secondary Current
3 Phase Welder
Frequency 3.75 Cycles Per Second
Fig 3

Fig. 3—Oscillogram of Secondary Current, Three-Phase Welder, Frequency 3.75 Cycles per Second

by the use of the Sciaky patented three-phase principle. The welding transformer is made with three separate primary windings and one low voltage secondary.

Referring to Fig. 4, we see three groups of primary coils: C1, C2, C3—secondary C4—and two sets of Ignitron tubes: Group A1, A2, A3 and Group B1, B2, B3.

By suitable control means, Ignitrons A1, A2 and A3 are allowed to become conductive for a preset interval of time, thus allowing electron current to flow in turn through coil group C1, C2 and C3 in the direction shown by dotted arrows. Ignitron group A is then rendered

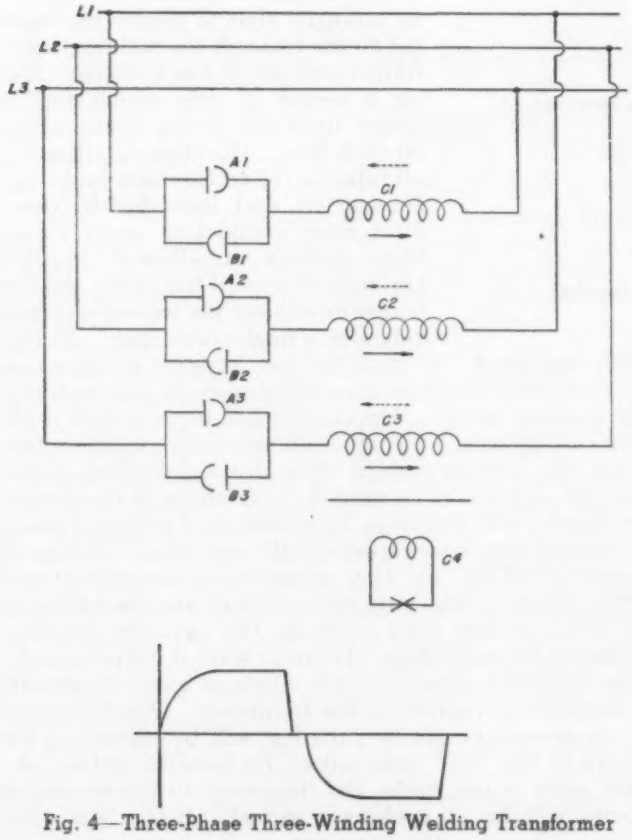


Fig. 4—Three-Phase Three-Winding Welding Transformer

nonconductive and ignitron group B is rendered conductive for the same period of time, thus allowing current to flow in the direction indicated by the solid arrows. This means that the current in the primaries reverses its direction at a predetermined rate and that the magnetic field in the core reverses its direction at the same rate. Since the secondary is wound upon the same core and is therefore affected by this field, a voltage will be generated in the secondary which will force a current through the secondary circuit which has the same characteristics as in the system previously described.

It is very evident that there are distinct advantages to welding with frequencies below 60 cycles. For instance, instead of the skin effect increasing the resistance in the secondary circuit to 2.3 times the d.-c. value, as it does when we operate on 60 cycles, if we operate in the neighborhood of 3 to 6 cycles per second, the increase in resistance due to skin effect is negligible. The introduction of heavy steel plates in the throat of a welder operating at low frequencies affects very little the current passing through the secondary circuit, thus making it unnecessary to place current compensating devices on a welder of this type.

Fig. 5—Oscillogram of the Line Current on a Three-Phase Half-Wave Rectifier Supplying a Three-Phase Single-Phase Welder

The rectifiers which are used for the production of direct current for this type of equipment are inherently high power factor devices. Three-phase rectifiers with Delta Star Anode transformers operate at power factors in the neighborhood of 80%; double three-phase rectifiers, using an inter-phase transformer, operate at a maximum of 95.5% power factor, with very high efficiencies. The current in each of the lines supplying three-phase welding machines is identical. This means that the heating effect is the same on each of the three lines and that the power distribution equipment is evenly loaded on all three phases. Figure 5 is an oscillogram taken of the line current on a three-phase half-wave rectifier supplying a three-phase Sciaky welder. Figure 6 is an oscillogram of the line current in each of the lines supplying a double three-phase rectifier connected to a three-phase welder. We can see from the oscillograms that there is absolutely no high current transient on the line. This favorable operation exists whether we use synchronous timing equipment to control the firing of the rectifiers for each impulse, or whether we use nonsynchronous relay type of equipment.

The power required to perform a certain welding operation, i.e., to weld the same material, is considerably less on the three-phase single-phase type welder than it is using single-phase 60-cycle equipment. We can see how this comes about if we examine the conditions under which a welding machine must operate. The usual welder has a throat depth of somewhere around 24 in. and is operated with spacings between horns of 8 to 10 in. It has been found that the secondary impedance under these conditions is somewhere in the neighborhood of 330 microhms. The power required to pass a certain current through the secondary is proportional to the square of the current and to the impedance of the second-

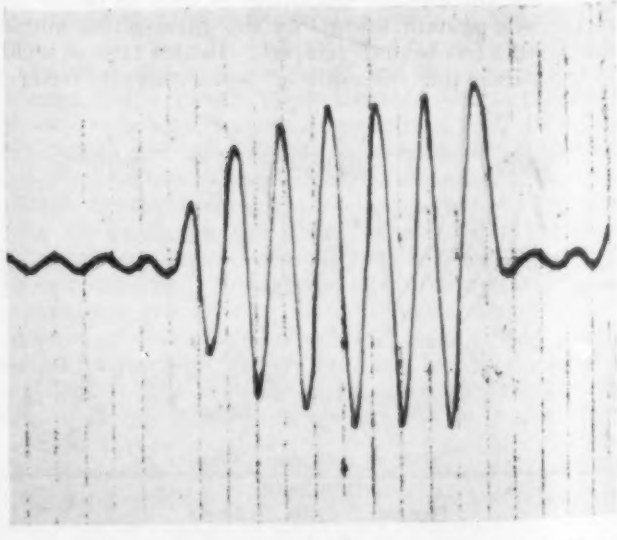


Fig. 6—Oscillogram of the Line Current in Each of the Lines Supplying a Double-Three-Phase Rectifier Connected to a Three-Phase Welder

ary circuit. In the case of the welder with a 24-in. throat the power required would be $I^2 \times 330$. If we operate the very same welder by passing a low frequency a.c. through the secondary the power required will be very close to $I^2 \times R_{d.c.}$ The d.-c. resistance of a welder of this type would be somewhere in the neighborhood of 25 microhms. This indicates that the power required would be 330/25 or 13.2 times greater in the case of a.-c. single-phase equipment than in the case of d.-c. or low-frequency equipment. We have found that although the power requirements between the single-phase system and the three-phase system are not in the ratio of 13 to 1, we still effect substantial savings in power in using the three-phase single-phase welding apparatus. Tests were conducted in the welding of $^1/_4$ plus $^1/_4$-in. clean mild steel on three-phase equipment of the type shown in Fig. 7, and on single-phase equipment of the same size. The curves in Figs. 8, 9 and 10 indicate the comparison between the two types of welders. All welding was done using a pressure of 4000 lb. and a time of 4 sec., with a spacing between welds of 5 times the sheet thickness. The electrodes used had a 2 in.

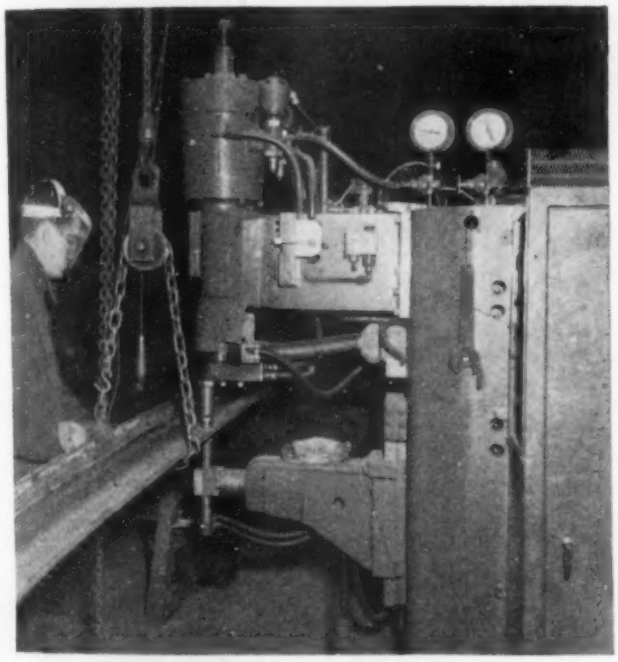


Fig. 7

radius with a $^1/_2$ in. flat. The single-phase welder demands 255 kva., whereas the three-phase welder demands slightly less than 100 kva. in performing the same quality welding operation. This is a ratio of 2.55 to 1. The line current on single-phase was 535 amp. as against 120 amp. in the case of the three-phase welder. This is a ratio of 4.46 to 1. In welders having greater throat depth than 24 in. more substantial reduction in kva. demand is effected since the throat impedance on a single-phase welder increases substantially with an increase in throat depth, whereas the d.-c. resistance increases very slightly, there being no more than a few microhms increase in resistance between a 24-in. throat machine and a 48-in. throat machine. The graphs show that the kva. demand on a 48-in. throat single-phase machine was 390 kva., whereas the three-phase machine had a demand of 105 kva. The line current to the single-phase welder was close to 800 amp. Line current on the three-phase welder was 140 amp. This is a ratio of 5.5 to 1. This reduction in power requirements becomes very evident when we are faced with a problem of welding heavy sections of material. For instance, in the welding of 3 pieces of $^1/_2$ in. or two thicknesses of $^5/_8$-in. scaly steel, the peak demand noted was 530 kva. in order to produce a weld which had an acceptable strength and appearance. This welding was done on the apparatus

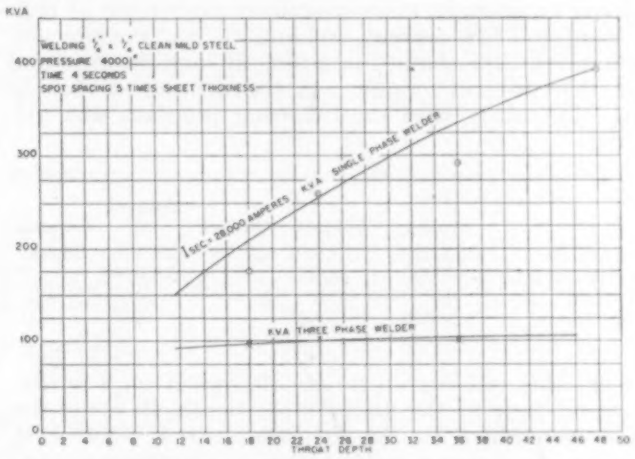

KVA
WELDING ¼" x ¼" CLEAN MILD STEEL
PRESSURE 4000#
TIME 4 SECONDS
SPOT SPACING 5 TIMES SHEET THICKNESS
400
300
200
100
0
1 SEC. = 28,000 AMPERES
KVA SINGLE PHASE WELDER
KVA THREE PHASE WELDER
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50
THROAT DEPTH

Fig. 8—Graph Showing Kva. Demand versus Throat Depth for Single-Phase and Three-Phase Welders

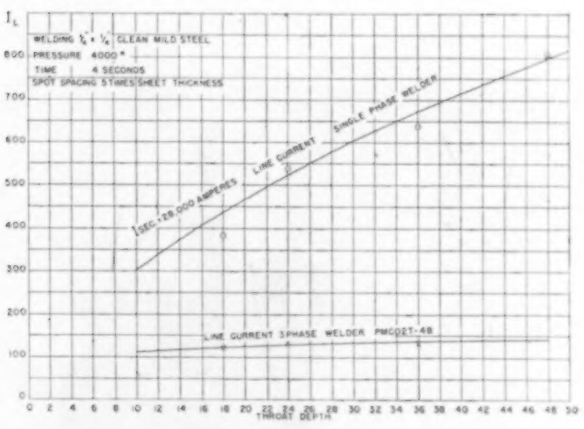


Fig. 9—Graph Showing Line Current versus Throat Depth for Single-Phase and Three-Phase Welders

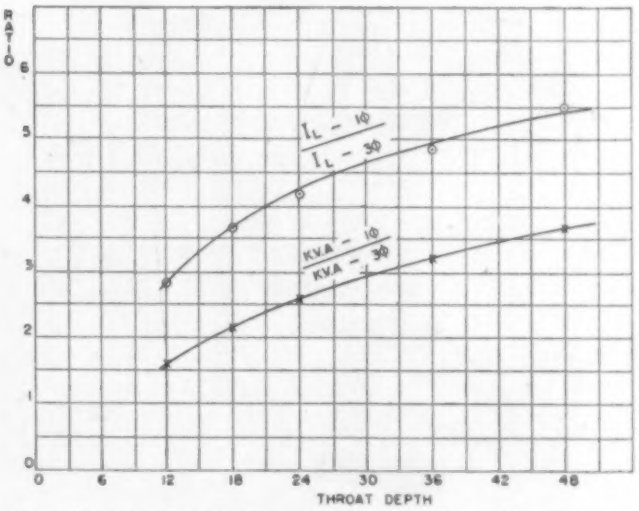


Fig. 10—Graph Indicating the Ratio of Line Current of a Single-Phase Welder to the Line Current of a Three-Phase Welder, and the Ratio of Kva. Single-Phase Against Three-Phase

shown in Fig. 11, which is a Sciaky type PMC5T2 portable unit designed for the welding of structural sections. This equipment allows a tip retraction of $17\frac{1}{2}$ in. to accommodate various types of structural members, and utilizes hydraulic equipment for the production of tip pressures as high as 25,000 lb. The control circuits are so designed that a complete welding program suitable for the welding of scaly material may be realized. This welding program includes descaling, preheating at high pressure and low current, welding at low pressure and high current, quenching, annealing at high pressure and high current, and forging. In the welding of the $\frac{5}{8}$-plus $\frac{5}{8}$-in. scaly steel the following program was utilized:

	Preheat	Welding	Quench	Annealing	Forging
Pressure, lb.	23,530	19,910	23,530	23,530	23,530
Current, amp.	47,000	78,500	0	78,500	0
Time, sec.	6	5.46	3.95	1.5	1.5
Kva. demand	230	532	0	532	0

Were this welding operation attempted on a single-phase machine of the same throat depth, it would demand somewhere in the neighborhood of 1800 kva. Whereas the power company supplying a customer may not find it too difficult to service him for a 530-kva. three-phase demand, they might be considerably hard pressed to supply a 1800-kva. single-phase demand. Furthermore, the installation of extra facilities for this higher demand would mean rather high expenditures in distribution apparatus and transformation equipment on the part of the power supply company which, of course, would be handed down to the user. Figure 10 indicates the ratio of single-phase to three-phase line currents, and the ratio of kva. single-phase against three-phase. We can see from this graph that for the 12-in. throat the line currents supplying a single-phase welder is 2.96 times as great as the line currents supplying a three-phase welder; and for a 48-in. throat machine the single-phase line currents would be 5.5 times the line current supplying a three-phase machine doing the same welding job. The kva. demand for a 12-in. throat machine will be 1.69 times higher on a single-phase machine than a three-phase machine; also, the power factor of the single-phase machine will be somewhere around 25%, whereas the power factor at which the three-phase machine operates will be above 80% and as high as 95%, depending upon the type of rectification equipment used. Therefore, the user will find that the installation of three-phase equipment will first of all lower the initial cost for extra facilities charged by the power company, and will also lower the operating cost cost since his peak demands will be lowered.

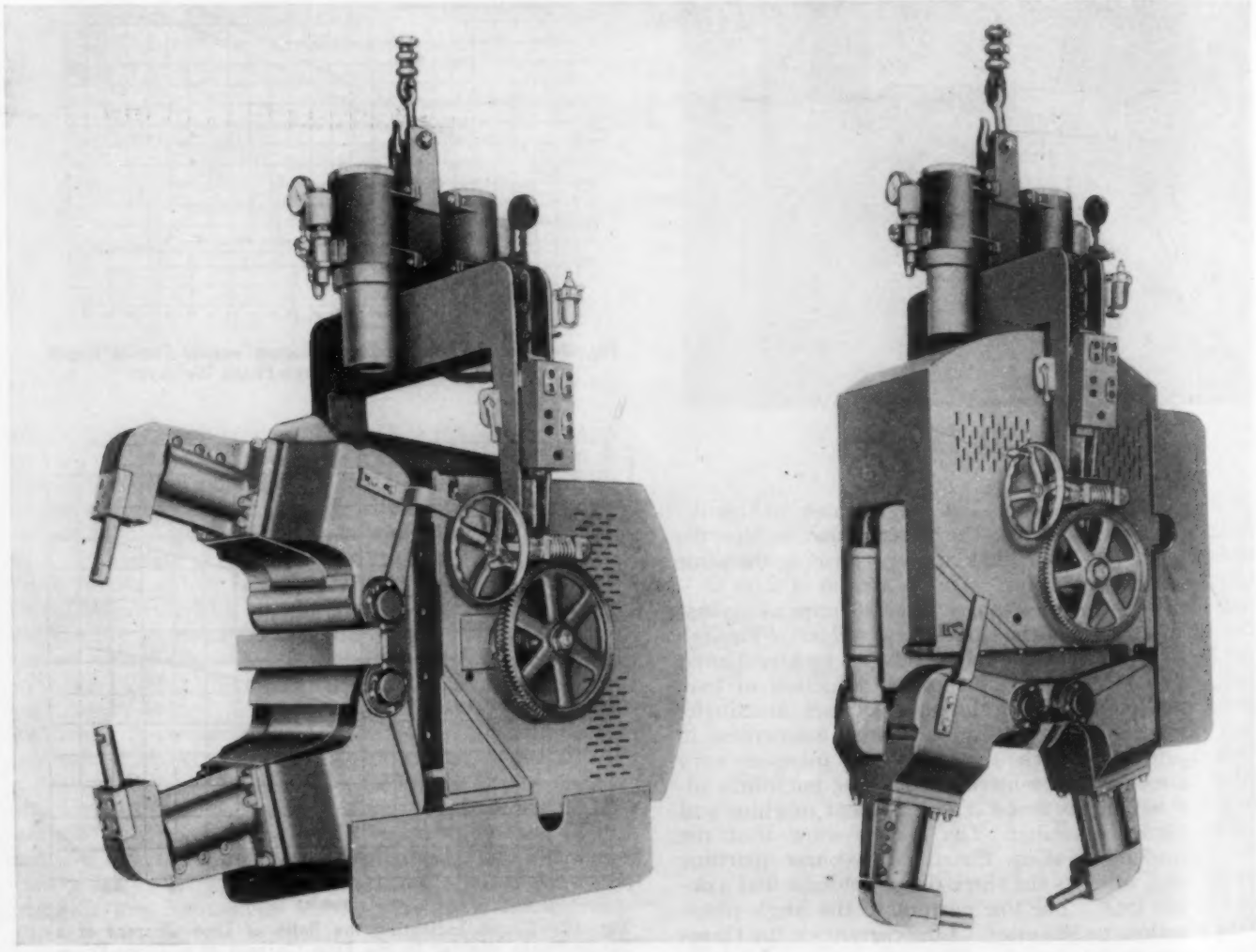


Fig. 11—Picture of PMC5T-2—Portable Unit Designed for the Welding of Structural Sections

Conclusions

It is evident that the three-phase equipment has a distinct advantage over the single-phase equipment, in that—

1. The power demand required to perform a specific welding job is lowered substantially.
2. The line currents in the three-phase system run from $^1/_4$ to $^1/_6$ of that found in using single-phase equipment for machines having throat depths normally used.
3. The line currents on each of the three lines supplying a three-phase welder are identical, thus producing uniform heating effects on all three lines and on all three phases of the distribution transformers and system.
4. There is no high current transient at the start of each impulse when using nonsynchronous control equipment on three phase welders.
5. Secondary current remains the same, irrespective of whether heavy steel sections are introduced into the throat of the machine.
6. Installation costs of extra facility equipment, switch gear and wiring are reduced over that needed for single-phase equipment.

A Comparison of Low-Pressure Vessels Constructed in Compliance with Different Codes or Regulations (with Specific Reference to Liquefied Petroleum Gases)*

By R. E. Cecil†

THE subject of this paper "A Comparison of Low-Pressure Vessels Constructed in Compliance with Different Codes or Regulations (with Specific Reference to Liquefied Petroleum Gases)" requires some explanation, also reference to the yardstick used for comparison. A purely statistical analysis will hardly tell the whole story, sometimes "one good reason why" is worth a good many figures.

There have been current in the United States and Canada several standards for fabricating pressure vessels, including Bureau of Marine Inspection and Navigation, or Coast Guard; American Bureau of Shipping; Lloyd's Register of Shipping; Interstate Commerce Commission for I.C.C. cylinders, tank cars, truck tanks; American Society of Mechanical Engineers—A.S.M.E. Code and joint code of the American Petroleum Institute and the American Society of Mechanical Engineers—A.P.I.-A.S.M.E. Each of these was formulated to meet some specific set of conditions or need, and has well served its purpose in accident prevention and also standardization, which makes for economy and conservation of resources.

These codes or regulations, with somewhat different approach and formulas, have not been static but are live growing things, modified or changed as new knowledge or experience dictates. Each has also profited by the experience of the others and has tended to grow toward a common standard until today there is not too much difference in the final answers. Some men serve on two or more of the last three committees mentioned above. While an individual may be positive the code with which he is most familiar is the best, nevertheless a careful study of the requirements of the codes and regulations or specifications and particularly the service and accident records would seem to indicate that it would require the wisdom of a Solomon to say which is the best.

As to the yardstick, it is assumed here that, regardless of opinion, the test of time and service will be conclusive if the time has been long enough and the number of vessels large enough; also absolute safety (or perfection) is ruled out as neither physically nor economically possible.

Narrowing the subject down to considering only containers for liquefied petroleum gases will practically limit comparison of containers to those constructed in accordance with either the I.C.C. Specifications or the A.S.M.E. Code or the A.P.I.-A.S.M.E. Code. These standards came into being in the order enumerated, beginning with the I.C.C. Specifications, the early part of this century. The time has been long enough and the number of vessels manufactured has certainly been large enough to justify a fair comparison of these three types.

Liquefied petroleum gas is now shipped or transported almost exclusively in I.C.C. 4B240 cylinders when the quantity by weight is not more than 300 lb. of gas. Quantities in excess of 300 lb. may be legally transported in tank cars or tank trucks. Stationary containers or tanks are constructed in compliance with the A.S.M.E. Code for use in states or cities which have adopted the A.S.M.E. Code as their standard, or with either the A.S.M.E. or A.P.I.-A.S.M.E. Code for use in other or non-code territory.

A comparison of the relative merits of these different types of containers becomes desirable when it is proposed to substitute one type for another, for example, placing an I.C.C. container in stationary service—either temporarily or otherwise.

Information about the design, construction, filling, care and use of I.C.C. cylinders has been largely confined to relatively small groups of people concerned with the manufacture of cylinders, the manufacturers of the contents of cylinders and the carriers (railroads). The public generally, even including the users of the contents of the cylinders, and state or Federal officials (except I.C.C.) have had little interest in or knowledge about the cylinder business.

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† Vice-President, Sales, Scaife Co., Oakmont, Pa.

This is natural and understandable; however, the bottled gas cylinder is becoming a household fixture, if not a necessity. It is highly desirable that public officials especially, and those filling and handling such cylinders, should be as well informed about cylinder construction and specifications as they are about boiler and tank construction and the A.S.M.E. and A.P.I.-A.S.M.E. codes.

Mere thickness of the steel in the wall of a container cannot be the yardstick for comparison. Many seem to consider the safety of a container as measured by its wall thickness, but this is not true. The yield and tensile strength of one steel may be 50% more or twice as great as another. One steel may be brittle and another ductile. This latter point is particularly important for liquefied petroleum gas containers as this gas is not in the gaseous phase but is normally a liquid when in the container, and only becomes a gas when it is let out of the container and the pressure becomes low enough.

Liquid propane, for example, is one of the lightest liquids shipped, weighing about half as much as water. It expands rapidly with temperature increase so that a properly filled cylinder at 60° F. will have a generous outage space, and will not nearly be liquid full; however, at 130° F. it will be almost liquid full and as the liquid is practically incompressible, any further temperature increase almost will cause the cylinder walls to be stretched regardless of thickness or strength of the steel. Cylinders, originally 14½ in. in diameter, have been returned to the manufacturer stretched to nearly an inch larger diameter. Accidental overfilling, even 4 or 5%, and a summer sun is hazardous; therefore a really ductile steel is a prime safety requisite.

The safety of a liquefied petroleum gas container is determined largely by the relationships of its diameter, the internal pressure, the thickness of shell and heads, the tensile and yield strength and ductility of the steel, and after these, the various other fabricating quality factors that really make the difference between a good safe vessel and one not so safe. These "other" things are what make up the bulk of the codes and cannot be enumerated here.

The A.P.I.-A.S.M.E. Code tabulates various "quality factors," each of which carries a definite premium of increased working pressure or a thinner wall for the same diameter and quality of steel. The A.S.M.E. Code accomplishes exactly the same results in its Paragraphs U-70 and U-69 and U-68 welded vessels.

The I.C.C. 4B Specifications provide for only one grade of a type, indicating all necessary operations and depending upon inspection and a peculiar type of test on each cylinder plus a random destruction test on one cylinder from each two hundred. In addition, accidents are carefully investigated if a defective cylinder appears to be the cause. Incidentally, there is also a little matter of a maximum of ten years in the penitentiary or $10,000 fine, or both, for willful violation.

The I.C.C. 4B Specification requires a steel with a maximum yield of 70% of tensile strength, whereas the A.S.M.E. and A.P.I.-A.S.M.E. codes use A.S.T.M. Specifications which specify a minimum yield of one-half tensile. There is no maximum yield limit in the A.S.M.E. or A.P.I. codes and, note especially, no minimum in the I.C.C. Specifications; however the I.C.C. requirement that each cylinder must be tested in a water jacket with gages capable of being read to 1% or 0.10 cc., and the requirement that the permanent expansion of the cylinder shall not exceed 10% of the total volumetric expansion at a test pressure of twice the service (or working) pressure is a searching test and assures that the steel is not too soft nor the yield point too low. However, such cylinders are ductile and usually yield or stretch enough to prevent rupture, if accidentally overfilled.

The public hearings held by the California Accident Commission at Fresno, April 26 and 27, and at Los Angeles, April 30 and May 1, 1945, and also the hearing at Los Angeles, August 6 and 7, 1946, in reference to Proposed Revision of "Liquefied Petroleum Gases—Safety Orders" were very interesting from the standpoint of revealing the general lack of knowledge and understanding or misconception of the I.C.C. Regulations and particularly Specifications. There was better understanding of the A.P.I. and the A.S.M.E. codes. The argument was largely about thickness—I.C.C. was lighter than the others, therefore less safe. F. L. Maker, W. C. Coakley and Turner Smith submitted testimony and exhibits showing a comparison of shell design formulas with calculations and comparative thickness of wall for 4B240 seamless cylinders and A.P.I. and A.S.M.E. seamless tanks. It was also brought out by Mr. Maker that comparing seamless I.C.C. cylinders and seamless A.P.I.-A.S.M.E. tanks there is very little difference in wall thickness, maybe 2%; however, under certain conditions the I.C.C. cylinder is lighter and in other cases the A.P.I. tank is lighter. For the cylinders usually used I believe the difference is less than 2%.

Now, this brings out one of the prevalent stumbling blocks, especially for those with a subconscious feeling that the thicker the vessel wall the safer. The I.C.C. cylinder and an A.P.I. tank, both seamless of same diameter with equal wall thickness and same steel, are equally safe. Now an A.P.I. or A.S.M.E. tank with a longitudinally welded seam is possibly 20% thicker for same diameter and working pressure, however, it is still only equally safe in the eyes of the law and the framers of the Code and will not be permitted any greater working pressure. The framers of the codes considered a seamless vessel the safest and a vessel with the same wall thickness but with a joint in it less safe, and have lowered the permissible working pressure.

Liquefied petroleum gas is entirely noncorrosive, therefore no added wall thickness is required. For a steel of 55,000–65,000 psi. tensile strength an allowable working stress of 13,750 psi. is correct for both A.S.M.E. and A.P.I.-A.S.M.E. codes. The 100-lb. cylinder is by far the most popular size. This is 14½ in. I.D. and designed for 240-lb. service pressure. The following tabulation shows the required wall thickness for the 100-lb. container, calculated by the I.C.C., A.P.I. and A.S.M.E. formulas, and using the above-mentioned steel.

Containers—14½ In. I.D. for 240-Psi. Internal Pressure

	Minimum Shell Thickness, In.		Minimum Shell Thickness, In.
I.C.C. Seamless	0.126	A.P.I. Seamless	0.128
I.C.C. Brazed	0.133	A.S.M.E. Seamless U-201	0.128

So far this is all very simple and understandable. It will be noted that there is no appreciable difference between the different types of seamless containers, far less than the permissible mill variation in sheet thickness. It represents a difference of permissible internal pressure of only 3.8 lb. or 1.58%. Not long ago the writer cut up some cylinders made in 1916, and that had been in continuous use in Pittsburgh steel and scrap yards. After washing off a brown film on the inside with water and a rag the original roll marks appeared, there was no surface pitting or attack. The steel was thoroughly tested and examined for aging effects and otherwise. Apparently the cylinders were good for another 30 or 60 years.

We now come to the apparent source of misunder-

standing. The table below shows the relative wall thickness of containers which are not seamless but which have welded joints and varying quality factors which result in joint efficiencies of 90, 80 and 70%. The thickness of the seamless container, first column, is taken as unity or 1.0.

Comparative Wall Thickness of Vessels of Same Diameter and Working pressure, But with Varying Joint Efficiencies

Type of Construction	Any Steel Shell Thickness,	Steel 25% Stronger Than First Column Shell Thickness,
Seamless	(Unity) 1.000	0.800
Welded, Joint Efficiency 90%	1.111	0.889
Welded, Joint Efficiency 80%	1.25	1.000
Welded, Joint Efficiency 70%	1.429	1.143

The second column is added to show that any other steel of different strength will indicate different shell thickness, relative to the steel shown in the first column. The big point is that vessels of all these varying thicknesses are considered to be equally safe and of equal strength and suitable for the same working pressure. The difference in thickness in the first column is 143% and between the 0.80 thickness in the second column and 1.429 in the first column the spread is 179%. However, this would seem to be perfectly justifiable in the light of present knowledge and experience.

Summary

On the whole, there appears to be little difference in wall thickness between seamless vessels using the same steel and constructed in accordance with the requirements of I.C.C. 4B Specification and vessels complying with the A.S.M.E. or A.P.I.-A.S.M.E. codes.

There is a difference in wall thickness between I.C.C. vessels and welded A.S.M.E. and A.P.I. vessels. The difference in thickness depends upon the various factors employed that result in different final joint efficiencies, and also the grade or strength of steel employed. From the standpoint of strength and safety, however, they are considered to be equal.

Huge numbers of liquefied petroleum gas cylinders have been put into use during the last thirty years. The service and accident records have been most excellent; this was substantiated by testimony at the California meetings referred to, and by other records. A. W. Kerr, Imperial Gas Co., Los Angeles, Calif., a pioneer in the business has maintained an accident clipping service covering the United States for many years and has introduced it as testimony on various occasions. This service has now been taken over as a routine activity of the Liquefied Petroleum Gas Association.

A.S.M.E. and A.P.I.-A.S.M.E. vessels have likewise had long and excellent service records—not only in the liquefied petroleum gas field but for many other services. Essentially there is very little difference between the constructional features of the A.S.M.E. and the A.P.I.-A.S.M.E. codes. The public generally and state enforcement officials are very well acquainted with and have knowledge of the safety record of these Code vessels.

There does not appear to be evidence that can be evaluated, either technical or from service and accident records, which would justify a finding that either type is superior to the other.

THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

DELHI SPEARHEADS CALSTEEL EXPANSION

A huge expansion program by the California Steel Products Company at its plant on Barrett Ave. and A St. was announced today by George F. Bent, president.

In an announcement which revealed that his company signed a $500,000 contract with the Jaeger Concrete Mixer Company of Columbus, Ohio, to manufacture the eastern firm's products for west coast delivery. Bent also said that several other eastern firms, unable to meet current demands for their products with present facilities, are now negotiating with his company to manufacture their merchandise for the western market.

"The steel fabricating business," said Bent, "has become firmly established in California and its future development possibilities are unlimited.

"We are gearing up to handle a tremendous increase of new business. Old established manufacturing firms east of the Mississippi now look to us to help them speed up production."

In line with this development Bent also announced the appointment of Lee W. Delhi as a director.

Delhi, nationally known engineer, is president of the AMERICAN WELDING SOCIETY. During the war, Delhi was production chief for the Western Pipe and Steel Company.

L. W. Delhi

"Delhi," Bent said, "will spearhead his company's development program, select additional personnel trained in the field of modern fabricating and welding techniques and attract new business to the Richmond plant.

New buildings will be erected on the company's present site of 6½ acres, and an additional 4 acres have been purchased on which to erect a modern streamlined pipe fabricating plant.

It is expected that the development program will cost several hundred thousand dollars and add several score employees to the payroll.

Calsteel will continue to progress in the development of welded products, particularly in alloys such as stainless, aluminum, as well as alloyed commercial pipe in which they do a considerable business.

MILWAUKEE PUTS IT OVER!

When it comes to Membership Drives, we offer our congratulations to the Milwaukee Section for a campaign which has produced somewhere in the neighborhood of 200 members.

Their first step was to send out cards soliciting the entire Milwaukee membership for assistance. Then under the Chairmanship of H. D. Reehl, a dinner meeting was held to organize the program. A large score-board was provided on which were posted six teams of campaigners made up from the list of cards returned and from a group of active members willing to help. Each team had a captain appointed by the Chairman. The plan was to conduct a person-to-person contact with every possible potential member, with only two weeks time allotted. Three dinner meetings were held during this time to stimulate canvassing and to follow the progress of the teams. Prizes were awarded to the three men, bringing in the largest number of members. Posters advertising the SOCIETY were put on display in many of the local plants, and an advertisment was placed in one of our local papers and A.W.S. booklets setting forth the advantages of the membership in the SOCIETY were widely distributed.

Shortly after the campaign was over, a stag smoker with an evening of entertainment, food and beer was provided to give the new members a chance to get acquainted. Each member was provided with a lapel tag of a distinguishing color to identify the new men.

We hope we haven't let any trade secrets slip, but we couldn't resist writing up a fine job of campaigning.

FOUNDATION OF APPLIED RESEARCH

San Antonio, Tex.—Designed to yield practical benefits to mankind, an integrated house of science, abundantly equipped with research laboratories, was opened today on a 3000-acre strip of fertile Texas prairie land 8 miles west of historic old San Antonio.

The amply endowed project, made possible by the gift of a valuable oil property by Tom B. Slick, San Antonio oil and ranch man, consists of 2 separate but closely associated units—the Foundation of Applied Research, utilizing famed Essar Ranch as part of its laboratory, and the Institute of Industrial Research, including a development service for inventors.

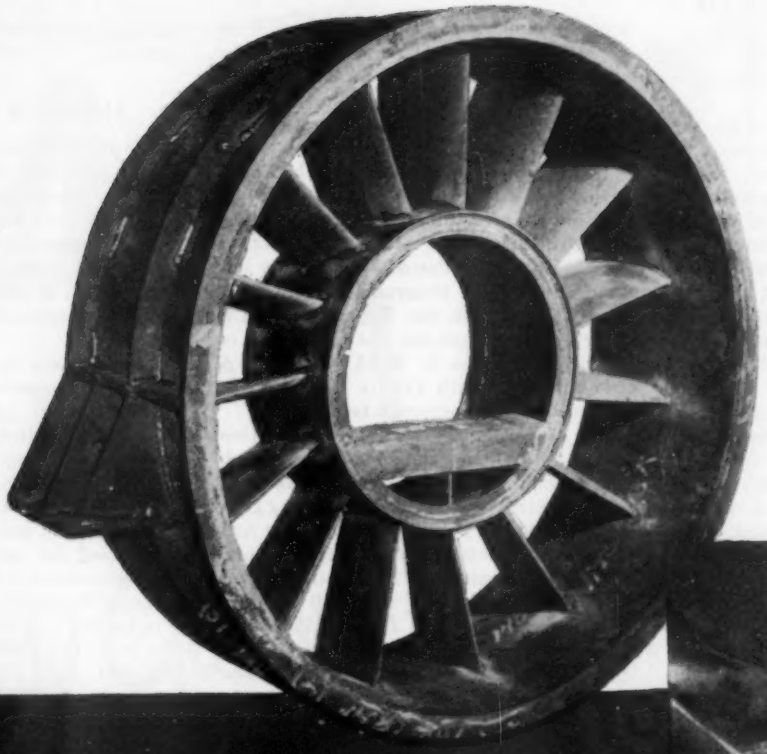
While the Foundation of Applied Research was incorporated by its trustees as a nonprofit undertaking, it has been designed to make its own way financially after a development period, from sales of Essar Ranch's blooded cattle, and from earnings by the Institute of Industrial Research through fees and patent proceeds.

Mr. Slick, a Phi Beta Kappa in Science at Yale University and successful inventor himself, will advise on the planning of the scientific program under the direction of trustees including C. F. Urschel, Sr., Earl F. Slick, Dr. Gregory Pincus, A. A. Seeligson, Jr., John J. Cox, George Grant, Leroy G. Denman, Jr., I. O. Gilbert, A. J. Baxter and Buel N. Wright.

Dr. Pincus, head of the Worcester Foundation for Experimental Biology at Worcester, Mass., and noted for his work in experimental embryology, is presently selecting the research men and scientists who will staff the Foundation and the Institute.

Objectives of the projects have been outlined by Mr. Slick as follows: "The only limitation to the scope of work to be undertaken by the Foundation is that it has in view a distinctly practical application," he said. "The value of pure scientific study is fully realized, but it is felt that the Foundation's greatest contribution can be realized by concentration on the field lying between pure scientific study as carried out by universities and similar institutions, and completely industrial research of limited range as conducted by the average industrial corporation. Between these extremes lies a promising field in which the Foundation will center it's efforts."

The Institute of Industrial Research, under separate management from the Foundation, will undertake on a fee basis for industrial corporations, programs similar to the services rendered by the Mellon, Armour and Midwest Institutes, and in



Guide vane assembly of Jeffrey Aerodyne mine-ventilating unit. This consists of 15 cast iron vanes welded between inner and outer rings of heavy-gauge steel sheet with 5/32" Ni-Rod electrodes.

• • •

Close-up of guide vane assembly. Note smooth appearance of welds. One bead around each corner is all that is needed to bond a vane securely to the steel rings.

How welding cast iron to steel with NI-ROD SAVED 300 OPERATIONS PER ASSEMBLY

The Jeffrey Manufacturing Company, of Columbus, Ohio ... makers of Aerodyne Fan mine ventilating units ... were looking for a faster, simpler method of building their large guide vane sections.

The stumbling block was the fact that the 15 vanes are *iron castings*. The inner and outer rings between which they are mounted, are *steel sheet*. Although welding seemed like the obvious answer, cast iron-to-steel joints have usually been a crossed-fingers proposition.

After experimenting with several electrodes, Jeffrey engineers remained convinced that their standard fabrication method was the only way.

Here's what they had to do: Four slots had to be cast into each vane. In the thin sections between each pair of slots, they drilled two rivet holes. Then they had to cut out 60 pieces of strip steel, drill them, and rivet them into the slots.

Add that all up and it amounts to this: 60 holes drilled in the vanes, 60 pieces of steel cut to size, 120 more holes drilled in the steel strips, and 60 rivets to set. That makes 300 time- and labor-consuming jobs on each assembly, not to speak of a difficult casting job to put the slots in the vanes, and the final step, welding the steel strips to the rims.

And then came NI-ROD with the solution they were seeking.*

Ni-Rod quickly furnishes strong, sound deposits between the iron and steel. The smooth weld beads run all the way around each corner of each vane . . . and are made without preheating.

* * *

On the basis of this experience, look over your own fabricating operations. Perhaps Ni-Rod can save you time and money in your production lines. You'll also find Ni-Rod great for general maintenance and repair work.

Ni-Rod comes in 3/32", 1/8", 5/32" and 3/16" diameters. Order a 5-lb. package from your nearest NI-ROD distributor. And, be sure to ask for a copy of the Ni-Rod Instruction Booklet.

*Reg. U. S. Pat. Off.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

NI-ROD IS DISTRIBUTED BY:

WHITEHEAD METAL PRODUCTS COMPANY, INC.
WILLIAMS and COMPANY, INC.
STEEL SALES CORP.
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METAL GOODS CORPORATION
METAL & THERMIT CORPORATION
HOLLUP CORPORATION
EAGLE METALS CO.
ROBERT W. BARTRAM
WILKINSON COMPANY, LTD.
NATIONAL CYLINDER GAS COMPANY

addition will provide inventors with a complete processing service should their projects be determined worthy of development.

The Foundation contemplates a broad program covering agricultural research, the natural sciences and medicine. The principal laboratory for agricultural research will be the Essar Ranch where experiments in farming, livestock improvement, veterinary medicine and chemurgy will be conducted. The natural science department will include divisions of physics, chemistry, biology and more specialized sciences. The medical department, besides research facilities, eventually may include a small hospital, and possibly will be affiliated with or include a medical school. Departmental publications of work accomplished will be issued, and other means of disseminating useful information to the public will be used.

The Institute's Industrial Research Division, performing work for corporations on a fee basis, will have departments for petroleum engineering, metallurgy, chemistry and physics. Staffed by engineers and technicians, its facilities will include a laboratory and machine shop, and drafting, pattern-making, foundry, forge, tin shop, welding and heat-treating equipment.

The invention development service of the Institute will assist deserving inventors who rarely have the finances, technical facilities, patent advice and sales experience to properly develop and market an invention. A committee will pass on the idea, contract with the inventor, conduct a patent search, file an application with the Patent Office and then process and market the patent.

In addition to these programs, the Foundation and Institute will cooperate closely with universities, public health authorities, agricultural research stations and other institutions. The Foundation already has financed research programs at the Worcester Foundation for Experimental Biology in Massachusetts, the University of Texas, and Texas A. & M. College. A close affiliation with Trinity University of San Antonio is contemplated.

In the development of the Foundation and the Institute, the old Cable Ranch House, long a landmark of the region, will not be destroyed. Instead it is being converted into the Foundation's library and will have a club room and apartments. Ranch style homes will be constructed for the Foundation's staff and will be augmented with lodges for distinguished guests who, with their families, will be invited to spend costless vacations. The directors feel that their guests' views, observations and advice will result in considerable benefit.

The trustees of the Foundation and the Institute intend to conduct the projects in a manner to furnish a useful service to agriculture and industry and, if their hopes and dreams materialize, to achieve significant contributions to the welfare of the nation.

ALUMINUM GAS-LINE TUBING

During the war years, Reynolds Metals Co., Louisville, discontinued its line of flexible aluminum tubing for connecting gas appliances to house piping and for use on appliances and accessories. Now the company announces resumption of the production of aluminum tubing approved by the American Gas Association for these services.

This tubing is supplied in 2S-O and 2S-$^1/_2$H aluminum in outside diameters ranging from $^1/_4$ to $1^1/_8$ in. For connecting gas appliances to house piping, wall thicknesses range from 0.049-in. for the $^1/_4$ to $^5/_8$-in. O.D. tubing inclusive; 0.058-in. for $^3/_4$-in. O.D.; and 0.065-in. for the $^7/_8$ to $1^1/_8$-in. sizes.

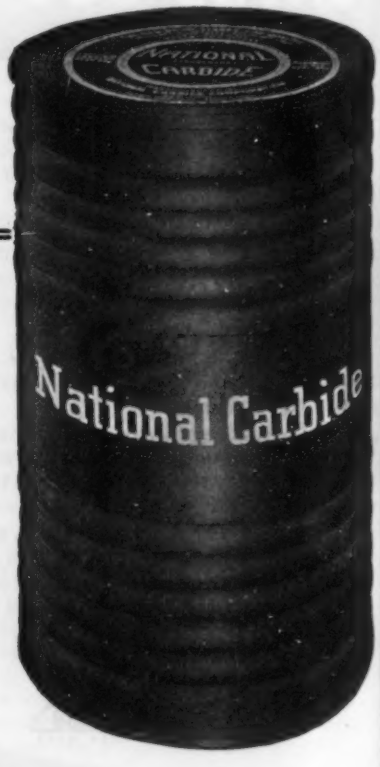
Tubing for use on appliances and accessories has a 0.032-in. wall thickness for $^1/_4$ and $^5/_{16}$-in. O.D.; 0.035-in. for $^3/_8$ and $^7/_{16}$-in. O.D.; 0.042-in. for the $^1/_2$, $^9/_{16}$ and $^5/_8$-in. O.D.; 0.049-in. for the $^3/_4$ and $^7/_8$ in. O.D.

Nominal weight for this aluminum tubing ranges from 0.026 to 0.257 pound per lineal foot. These values are about one-third the weight of similar copper tubing, copper weighing 3.3 times as much as aluminum.

The aluminum tubing is supplied both in straight lengths and in coils. All this

National
Carbide
IN THE RED DRUM

EFFICIENT
ECONOMICAL
DEPENDABLE

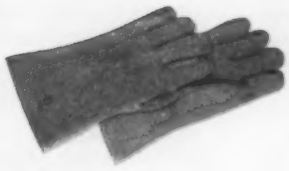


FOR WELDING and CUTTING
Use National Carbide in the Red Drum
Write us for information as to nearest available stock.
60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York 17, N. Y.

4

Of the Foremost for Serviceability in

Safety Clothing



AO 5X163 Welding Gloves. This popular glove of chrome-tanned split horsehide leather offers exceptional resistance to heat—assures extra protection on gas welding and heaviest amperage electric welding. Welted seams. Extra heavy lining on back. Look for long wear and comfort.

AO 208 BCL Cape Sleeve with Detachable Bib. Chrome-tanned cowhide. Rugged protection for arms, chest and shoulders.

AO 4903 CL Spat. Protects ankle and instep. Easily adjusted at top and under instep. Chrome-tanned cowhide.

AO 207 CL Overall. Chrome-tanned cowhide. All seams double cotton stitched, steel sewed. Large one-piece bib. Buckles on shoulder straps for easy adjustment.

Your skilled welders deserve the best in safety clothing for their *protection* and your *production*—and AO supplies it. There is a complete line of AO safety clothing "custom tailored" for every industrial need—designed to provide maximum safety with comfort and durability. Your nearest AO office can supply you.

Safety Division

American Optical COMPANY

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

material is approved by the American Gas Association and meets the requirements of American Standards Association as specified in "American Standard Listing Requirements for Semi-Rigid Gas Appliance Tubing and Fittings," ASA-Z21.24—1941.

Aluminum tubing should be used with aluminum compression type fittings for connections. Such tubing is widely employed for pilot lines on automatic gas furnaces, hot water heaters and the like where the use of aluminum is growing rapidly due to its greater availability and much lower cost compared with copper tubing.

BOILER CODE REVISION HEARINGS ANNOUNCED BY A.S.M.E. FOR MAY IN HOUSTON AND LOS ANGELES

The Boiler Committee of The American Society of Mechanical Engineers held two public hearings in the Southwest on the proposed revision of Section VIII of the A.S.M.E. Boiler Construction Code (Unfired Pressure Vessel Code). The special committee for this revision submitted its draft in January.

The first hearing opened Thursday, May 1st, at 8 P.M at the Rice Hotel in Houston, Tex., and continued May 2nd at 9:30 A.M. Sponsor was the A.S.M.E. South Texas Section. The second hearing was held at the Biltmore Hotel in Los Angeles on Wednesday, May 7th, at 9:30 A.M., with the Southern California Section sponsoring.

Members of the Boiler Code Committee, with its subcommittees, traveled in a group to attend the hearings and remained for their May meeting at the Biltmore, Los Angeles, on Friday, May 9th.

The purpose of the hearings was to provide an opportunity for verbal comment and discussion of the proposed revision. The Boiler Code Committee was anxious to attract pressure vessel manufacturers and users, state officials, representatives from the petroleum industry, enforcement authorities and any others interested.

Copies of the proposed revision are obtainable from the A.S.M.E., 29 West 39th St., New York 18, N. Y., at $1.00 per copy. Comments in writing to the Secretary of the Boiler Code Committee are invited.

The National Board of Boiler and Pressure Vessel Inspectors held its General Meeting on May 5th, 6th and 8th at the Biltmore in Los Angeles. Its members, who constitute the Conference Committee of the Boiler Code Committee attended the hearings and meetings.

MEETING OF BOARD OF DIRECTORS

A meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held February 14, 1947, at the E.S.D. Rackham Memorial Bldg., Detroit, Mich.

The meeting was called to order by President Delhi at 10:10 A.M., with the following present:

Members: L. W. Delhi, *President*, D. Arnott, R. W. Clark, D. H. Corey, R. S Donald, O. B. J. Fraser, H. O. Hill, G. O. Hoglund, C. H. Jennings, J. F. Lincoln, R. E. McFarland, L. S. McPhee, J. F. Maine, H. M. Priest, and R. D. Thomas.

Staff members: M. M. Kelly, *Secretary*, and L. M. Dalcher, *Technical Secretary*.

Amendment of By-Laws

Upon motion, duly seconded, the following amendment of Article II, Section 2, last sentence, of the By-Laws, proposed by the By-Laws Committee, was approved:

"Honorary Members shall be elected *at a regular meeting* of the Board by the unanimous vote of the members *present*, except that no member of the Board of Directors shall vote upon his own admission."

Finances

The treasurer drew attention particularly to improvement in the Society's cash position, net worth and consolidated resources as of December 31, 1946, compared with a year ago; excess of income over expense of $1101.94; and betterment of actual experience over estimated budget at end of the three-month period ended December 31, 1946.

Separate Welding Show

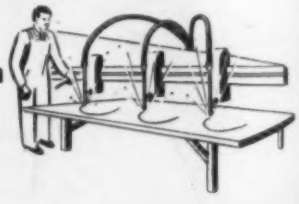
Progress report of special committee to investigate means of holding a separate welding exhibit sponsored by A. W.S., date January 31, 1947, and submitted to Board members for study in advance of this meeting, was read by Mr. Fraser in the absence of Chairman Pierce. Mr. Fraser reported

FOR THESE JOBS . . .

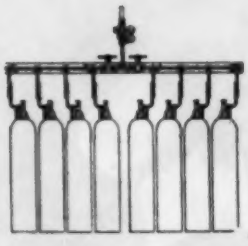
Production Welding

. . . and operations such as welding and cutting heavy sections with hand torches, flame hardening and softening, flame cleaning . . . also any installation where a battery of cylinders is required.

Production Cutting

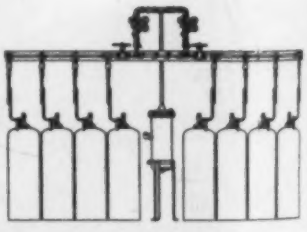


YOU NEED THESE MANIFOLDS . . .



REGO Oxygen Manifold

REGO Acetylene Manifold



BECAUSE OF THESE ADVANTAGES...

● *Added Convenience*... Individual shut-off valves at each cylinder station permit the removal of any cylinder without shutting down one side of the manifold. Master shut-off valves control flow of each bank of cylinders.

● *Unit Construction*... Header assembly, mounted to steel I-beam, is virtually one piece. Extra-heavy pipe is run through header fittings, cylinder station shut-off valves and master shut-off valves with all permanent connections silver-brazed.

● *Precision Regulation*... Uniform delivery pressure is assured by large capacity two-stage Regulators.

● *Exacting Tests* . . . Every RegO Manifold is subjected to a sustained air pressure test before shipment.

REGO

REGO Manifolds for Oxygen . . . Acetylene . . . Hydrogen . . . Nitrogen and other high pressure gases

There Is A RegO Manifold to Fit Your Most Exacting Requirements

The BASTIAN-BLESSING Company

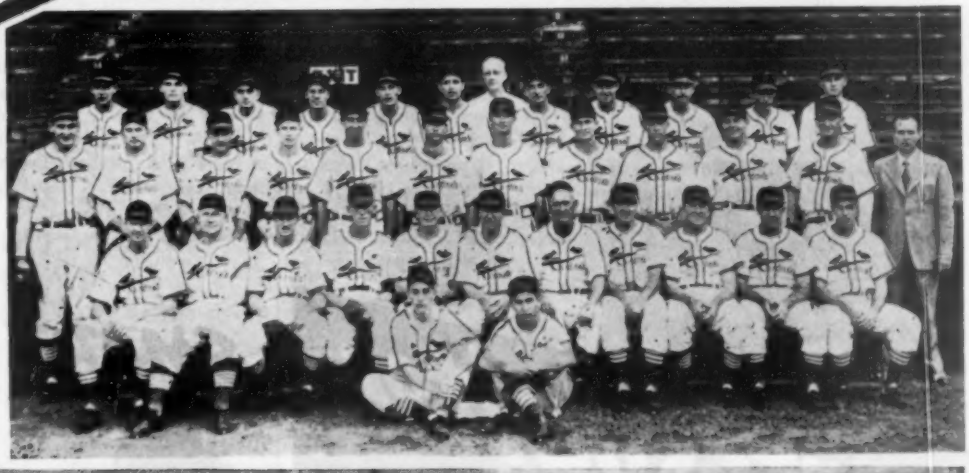
4201 W. Peterson Avenue Chicago 30, Illinois

Pioneer and Leader in the Design and Manufacture of Precision Equipment For Using and Controlling High Pressure Gases

BLUE DEVIL - E 6010
BLUEDAC - E 6011
GRAY DEVIL - E 6012
GRAY DEVIL No. 2 - E 6012
GRAYDAC - E 6013
BLACK DEVIL - E 6020
RED DEVIL - E 6030
BLACK DEVIL No. 75 - E 7020
RED DEVIL No. 75 - E 7030

You can expect Star Performance from

A TEAM OF CHAMPIONS



The 1946 World Series Champions, the St. Louis Cardinals—big league team that had what it takes to come out on top.

A team of *Champion Welding Electrodes*, like a team of champion athletes, is dependable, versatile, rugged and fast. In all positions uniform performance and stamina contribute to that perfect co-ordination which licks the toughest jobs and scores a hit with the customers. For consistently top notch results on your welding problems remember "They Have to be Good to be CHAMPIONS."

Pierre Champion

THE CHAMPION RIVET COMPANY

CLEVELAND, OHIO — EAST CHICAGO, IND.

that further investigational work is going on and it is hoped final conclusion can be reached shortly.

Publication of Third Edition of Welding Handbook

In the absence of Chairman Boardman, Mr. Dalcher reported progress to date. He stated that the Handbook Committee had held a meeting in New York on February 13th, which was the first meeting the Committee had held since last September. At this meeting, consideration was given to the adoption of policies for the preparation and editing of the forthcoming edition. In addition, the Committee reconsidered the scope, content and arrangement of the chapters and decided upon quite a few changes, including the inclusion of five or six new chapters. The status of the work on the Handbook is that very little has been accomplished since last summer. The Chapter Committees (with the exception of the new chapters decided upon on February 13th) are virtually complete and five or six chapters have been outlined. Since the new editors were appointed, activities on the Handbook have been mainly in the nature of preparing a sound groundwork of principles and procedures for preparing the individual chapters. Now that this groundwork has been established, it is anticipated that progress will proceed from this point at a satisfactory rate.

Executive Secretary

Questions arose regarding selection of candidate, salary to be paid, assignment of duties and manner of meeting additional expense for the proposed expansion program. In regard to selection of candidate, Mr. Hill stated that, when the committee believes it has three or four acceptable applicants, it is the intention to call for a special meeting of the Board, where the candidates will be introduced, a summary of their qualifications presented and final selection will be made.

Recommendations of Technical Activities Committee

In the absence of Chairman Pierce, Mr. Delcher presented the Committee's recommendations and following are actions taken thereon:

Revised Standard Specifications for Welded Highway and Railway Bridges: It was voted to approve recommendation of T.A.C. for the adoption and publication, as an additional standard of the Society, revised Standard Specifications for Welded Highway and Railway Bridges, submitted with the agenda.

Discharge of A.W.S. Aircraft Welding Committee: It was voted to approve recommendation of T.A.C. that the A.W.S. Aircraft Welding Committee be discharged and that the Aircraft Industries Association be extended invitation to appoint a representative on any A.W.S. technical committee in which they may be interested.

Appointment of Alternate A.W.S. Representative on A.S.A. Sectional Committees Z2 and Z5: It was voted to approve recommendation of T.A.C. that S. A. Greenberg be appointed as alternate to H. F. Reinhard as the A.W.S. representative on A.S.A. Sectional Committees Z2 and Z5.

Miller Medalist

Mr. Corey announced that Dr. A. B. Kinzel was selected unanimously by the Awards Committee as the 1946 Samuel Wylie Miller Memorial Medalist.

Membership Status

It was reported that the net gain in membership from January 1st to February 10th amounted to 201 members (1A, 66B, 132C and 2D), bringing the total membership, as of February 10th, up to 7732. Of this total, 6644 are active members and 1088 deliquent over two months. Since January 1st, 112 members in arrears have paid dues. Reports received from the Sections indicate that they are giving considerable attention to the collection of delinquent dues.

Annual Meeting Program and Arrangements

It was the sense of the meeting that Annual Meeting papers should be of a higher level. No paper should be scheduled on the program that does not contribute something new to the art and science of welding. As a means of determining the fitness of a paper for inclusion on the program, it was suggested that the Program Committee require authors to submit synopsis of paper with title, and to

anti-spatter twins

CUT CLEAN-UP COSTS

Save yourself operation headaches and speed production with Thompson Anti-Spatter. All spatter is easily removed because two types fit every welding operation.

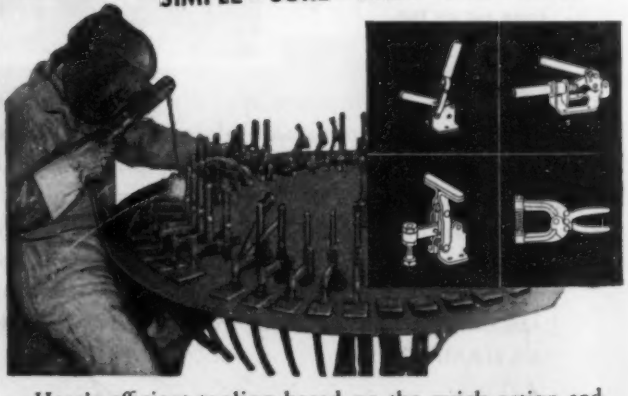
PICKLE-OFF, No. SO 317 is used where the job is to be pickled and not to be painted over.

NO-CLEAN, No. SO 327 is used where the work is not pickled. It leaves a clean surface for painting.

Thompson Anti-Spatter is easy to apply. Just brush, spray or wipe along edges to be welded. Either type $1.70 a gallon in 5-gallon cans. *Send for trial order.*

THOMPSON & COMPANY
OAKMONT (Pittsburgh District), PENNSYLVANIA
Manufacturers of Quality Paint Products Since 1847

SMART TOOLING!
SIMPLE – SURE – FAST – FOOLPROOF



Here's efficient tooling based on the quick action and positive holding power of De-Sta-Co Toggle Clamps. This simple turntable with its 48 No. 210-S clamps enables one welder to keep abreast of two helpers. One places curved shank in socket and unloads finished assemblies. The other locates pierced hole in plate over shank and locks securely with toggle clamp. The expert welder works without interruption.

Smart tooling like this is the backbone of modern mass-production technique. You'll see De-Sta-Co Toggle Clamps playing vital parts *wherever* the principles of sound tool engineering are observed. Welding production is *only one* of the many fields for quick acting clamps. For holding parts in milling, drilling, routing, riveting, cementing—for fast, uniform, *foolproof* action—progressive tooling demands De-Sta-Co adaptability and quality. There's a De-Sta-Co clamp for every job, designed and built to stand up under the wear and tear of volume production. Send for copy of Catalog No. 47.

DETROIT STAMPING COMPANY
322 Midland Ave. Detroit 3, Mich.

Stronger, Lighter Hand Truck Made by Welding Tubular High Carbon Steel

BY JAMES B. HOWLAND, PARTNER
TUBAR BENDING & MANUFACTURING CO., CLEVELAND, OHIO

THE new Tubar Hand Truck has outstanding strength and low weight because it is made of tubular high carbon steel with an exceptionally thin wall (.076″). Frame of the largest model Tubar weighs only 36 pounds, yet carries a 1,000-lb. load. Fig. 1 shows how light it is. The addition of reinforcing tubes from the kick-bar to the handle (see Fig. 3) makes a "stevedore" model with a 2,500-lb. capacity. Conventional hand trucks of these capacities weigh more than twice as much.

The all-welded tubular frame has other advantages in addition to lightness. Constructed without bolts or rivets, it has a smooth top and bed without obstructions. There is no danger from wood splinters or sharp edges of metal. Design of the frame distributes the load and reduces dead weight on the axle, facilitating handling. The operator's hands follow the curve of the handle in "breaking" the load to a pulling or pushing position. The Tubar Truck is patented.

Fig. 1. Demonstrating the lightness of the Tubar truck.

JIGS USED IN WELDING

We use two sizes of tubing—1 1/16″ O.D. and 7/8″ O.D. The smaller telescopes into the larger size at the maximum stress point, for greater strength. The tubes are bent on a bending machine (see Fig. 2). The toe plates are bevelled and forged to a point. Toe-plate sides are cut from 3/4″ high carbon steel plate by an acetylene cutting machine. The frame parts are assembled in a jig and tack-welded, then finish-welded in another jig (see Fig. 3).

In setting up production, we had difficulty welding the high carbon tubing until we tried the new Lincoln "Shield-Arc LH-70" electrode, designed for high carbon and other difficult-to-weld steels. With "Shield-Arc LH-70" we are able to weld speedily without costly preheating or special welding procedures.

Further information on the procedure for this electrode may be obtained by writing THE LINCOLN ELECTRIC COMPANY, Dept. 125, Cleveland 1, Ohio.

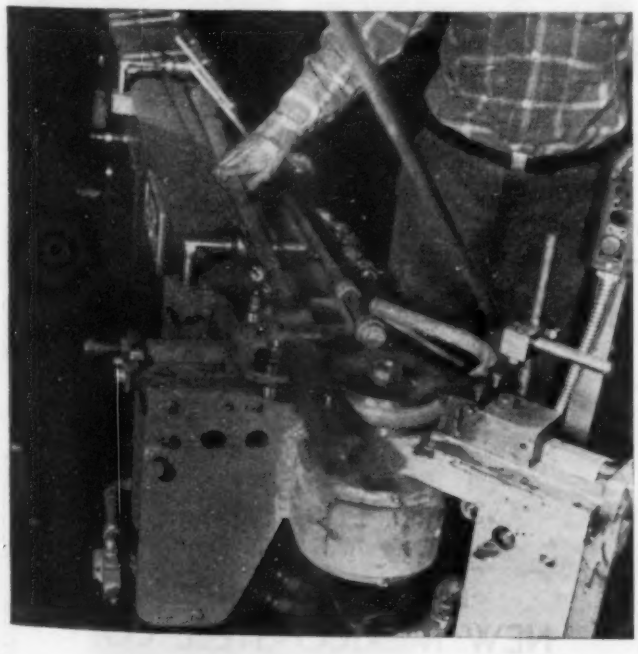


Fig. 2. All bending is performed on a tube bending machine.

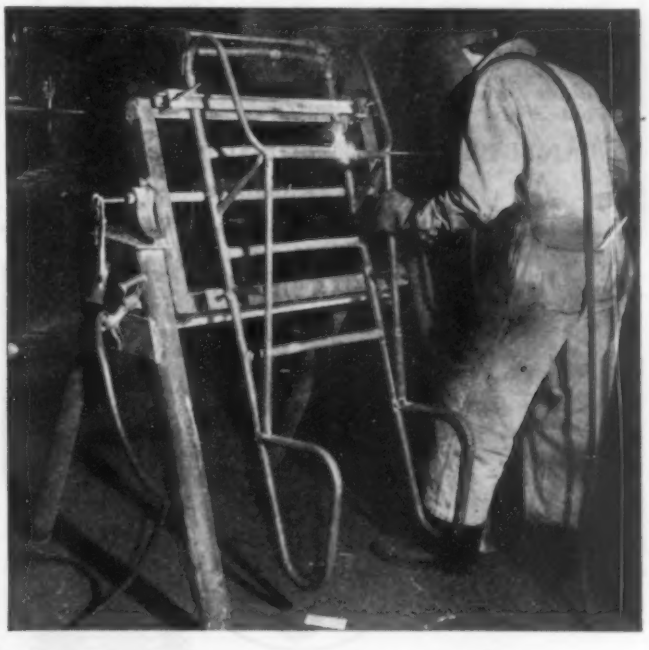


Fig. 3. Finish-welding a "stevedore" model. Jig rotates so most welding is in downhand position.

meet deadline for receipt of paper, set sufficiently in advance of meeting to permit paper to be reviewed either by a small board of experts in the field, or members of the Program Committee, before presentation. It was recommended that the Program Committee permit no paper to be read at an Annual Meeting that has not been reviewed in advance of the Meeting and found acceptable to the Program Committee. It was felt generally that past programs have been overcrowded and it would be desirable to schedule fewer papers of higher quality; also, it was believed desirable that consideration be given to means of exercising greater control over time allotted to speakers and discussors.

The Secretary was instructed to schedule subject "Annual Meeting Papers and Arrangements" on agenda of next Board meeting and to invite the Chairman of the Program, Convention and Manufacturers Committees to that meeting, so that they can present the findings of their Committees and participate in the discussion.

Western Metal Congress

The President reviewed briefly the program of the Pacific Coast District Meeting being held in San Francisco, March 22nd to 28th, in conjunction with the Western Metal Congress. He pointed out that the committee had endeavored to meet wishes of the Manufacturers Committee in keeping two afternoons free for inspection of exhibits and in holding technical sessions in the exhibit auditorium.

In view of the fact a quorum cannot attend, he reported that the Board of Directors' meeting in San Francisco has been cancelled. It is his intention merely to discuss matters informally with members of the Board present in San Francisco during the week of the Congress.

Next Board Meeting

It was left in the hands of Mr. Hill to determine whether an Executive Committee or Board of Directors' meeting is needed in April, and Mr. Hill was asked to set the date for such meeting. No change was made in plans for holding Board meeting in Chicago on May 16th.

THE DUTCH WELDING SOCIETY

The Dutch Welding Society was founded in 1921 with the object of advancing the science and art of welding in all its ramifications. The Society tries to obtain these aims by organizing meetings, conferences, congresses, lecture courses, demonstrations, symposia, supplementary training of welders, publications, etc.

At the head of the Society is a Board of Directors. Local Sections are established in the provinces of North-Brabant, South-Holland, Sealand, North-Holland Utrecht, Limburg and Groningen and in the city of Gorinchem.

The Board of Directors consists of 9 permanent members, the presidents of the local sections, 2 members delegated by the government and 2 delegates of the welding industry. The Headquarters of the Society are in the Hague, Stadhouderslaan 102, tel. 555743.

The monthly publication is entitled: "Laschtechniek" (Welding), which is sent to all members.

Every year a symposium on welding is held, sometimes combined with a welding exposition, as it is this year in Utrecht on June 3, 4 and 5, 1947.

The membership may be:

Sustaining members...Minimum	$10.00
Members	$ 3.00
Associate and student members	$ 1.80

The Society had on January 1, 1947 a membership status of:

Sustaining members	107
Members	807
Associate and student members	2584
Total	3498

The associate members consist for a great part of operating members as welders, foremen, etc. The Society includes also the working welders of the industry.

BOUND VOLUMES

We have received requests for copies of the Bound Volumes of THE WELDING JOURNAL for the years 1939 and 1942. If any members have copies of either or both of these volumes, the Society will pay them $5.00 each on receipt of same.

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them

The Trade-Name is "ANTI-BORAX"

Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4 for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; No. 16 Silver Solder Paste Flux.

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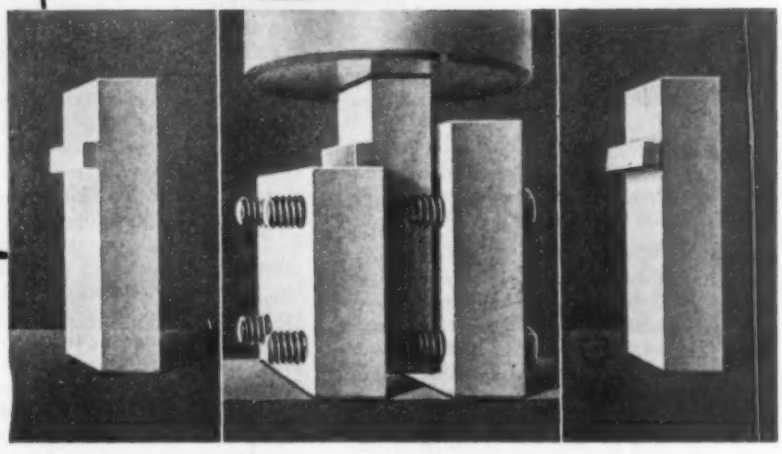


Stainless-Clad Steel plate specimens (left), when subjected to shear strength tests (center), sustained pressures of over 48,000 psi, average, showing the high strength of the bond. The specimen (right), shown after test, failed at 48,600 psi.

DESIGNERS and fabricators of corrosion-resistant equipment are offered, in Lukens Stainless-Clad Steels, economical clad plates that stay bonded during fabrication and under normal conditions of temperature change, pressure, vacuum or mechanical shock.

So strong is this bond that in shear strength tests it has sustained pressures of over 48,000 psi. Thus it readily meets the 20,000 psi minimum strength requirements of the ASME Code. This high-strength bond is the result of Lukens production method, developed during 17 years of experience with clad steels.

Lukens Stainless-Clad Steels, insuring the corrosion resistance, product protection and wearability of solid stainless at substantial savings in cost, are furnished in all standard stainless types, including 304, 316, 347, 410, 430 and others. They are available in uniformly maintained cladding thicknesses from 5% to 50%, and in plate thicknesses from 3/16″ to over 3″, or in widths to 178″.

Additional information on Lukens Stainless-Clad Steels is offered in the new Bulletin 338; on Lukens Nickel-Clad, Inconel-Clad and Monel-Clad Steels in Bulletin 255. Please write for copies. Lukens Steel Company, 407 Lukens Building, Coatesville, Pa.

LUKENS

Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

1946 BOUND VOLUME

Copies of the 1946 Bound Volume of THE WELDING JOURNAL are now available. Price to Members, $10.00; nonmembers, $11.00. Order through the AMERICAN WELDING SOCIETY, 33 West 39th St., New York 18, N. Y.

A.S.T.M. COMMITTEE A-10 ON IRON-CHROMIUM-NICKEL AND RELATED ALLOYS

A report on the progress on tabulating the chemical, physical and mechanical data on cast corrosion and heat-resistant iron-chromium-nickel alloys and a revision of the publication issued in 1942 on similar wrought alloys featured the meeting of A.S.T.M. Committee A-10 on Iron-Chromium-Nickel and Related Alloys and several of its subcommittees during A.S.T.M. Committee Week in Philadelphia.

The new data book on cast alloys, which will be published with the revised data on wrought alloys, has now advanced to final vote in the committee, and should be available before the end of the current year.

The subcommittee on corrosion testing is completing the final details of its new program for atmospheric corrosion testing and reviewed a number of important items as follows:

1. Included in the test program will be light-gage arc-welded samples.
2. Likewise Type 301 arc-welded samples, 1/8 in. thick, will be used. These arc-welded samples are in addition to spot-welded coupons.
3. Specimens of 18–4–4 composition may be included in the program.

Some further changes in the test program are being considered but it is expected to be in final form by June of this year, when the committee will approach the stainless steel manufacturers with a request for samples. Each manufacturer will be asked to supply a complete set of samples representing one grade of stainless steel.

The subcommittee on specifications for bars, forgings and wire is preparing three new specifications. These will cover hot- and cold-drawn bars; spring wire of the 18Cr–8Ni type, and a specification covering some 23 forgeable stainless steel alloys. In designating these alloys within A.S.T.M. specifications, the committee voted to follow, as far as possible, A.I.S.I. designations, such as "Type 304, 316," etc., with prefixed letter sympols such as "SW" for "stainless wire," to indicate the class or ultimate use of the material.

The subcommittee on specifications for flat products is considering requests for the addition of several new grades and the use of a flat 8-in. test specimen in place of round, in several existing plate specifications. The subcommittee is also studying the effect which the speed of testing has on mechanical properties.

The subcommittee on specifications for tubular products is considering advancing four of its specifications (A 268, A 269, A 270, A 271) to standard, and the subcommittee on metallography is continuing its work on the program for the detection of sigma phase in chromium and chromium-nickel steels.

The officers of Committee A-10 are Chairman, Jerome Strauss, Vanadium Corp. of America, New York, N. Y.; and Secretary, H. D. Newell, The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

MACHINE-SHOP ESTIMATING

Machine-Shop Estimating, by W. A. Nordhoff, Douglas Aircraft Co., Inc. Published by McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 18, N. Y. Price, $6.00. This book provides a scientific basis for evaluating the performance of machine shop operators by showing how to estimate the time it should require to perform a job. The book lists all of the elements of operations performed in an average machine shop and establishes reasonable time values for their execution by the average operator. All machine operations are fully described and various methods of estimating the time required to fabricate machined parts are explained. Tables supply machinery elements which are generally variable. Sample estimates are shown for all machine operations to assist the reader in doing his own estimating.

BURDETT APPOINTMENTS

The Burdett Oxygen Co. of Cleveland, Ohio, has announced several new appointments for its subsidiary, the California Air Products of Los Angeles. With the new California plant nearing completion, William H. Loveman, President, announced recently that Jack Bernstein, formerly of Cleveland and Ashtabula, Ohio, will be manager of operations. William Young, formerly manager of the Cleveland acetylene plant, will be in charge of the construction of the acetylene plant in Los Angeles. Winfield Rice, formerly of the oxygen industry in Portland, Ore. will be superintendent of the oxygen plant.

Mr. Loveman said, "Due to the great expansion in the need for industrial gases, we are bringing new facilities closer to our customers so that there be less time lost in meeting their requirements promptly."

Burdett Oxygen Co. offers a complete line of welding and cutting equipment and supplies, and protective equipment as well as industrial gases.

CORRECTION

The name of the manufacturer, The Taylor-Winfield Corp., Warren, Ohio, was inadvertently omitted from the New Products item entitled "Press Welders," which appeared on page 278 of the March issue of THE WELDING JOURNAL.

L. S. MOISSEIFF MEMORIAL COMMITTEE

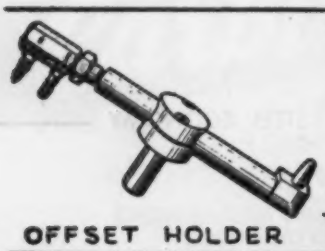
During the past year the L. S. Moisseiff Memorial Committee has been very active. The following officers were elected Shortridge Hardesty, *Chairman;* F. H. Frankland, *Vice-Chairman*, F. Lienhard, *Secretary-Treasurer.*

The purpose of the Committee is to raise sufficient funds to establish the L. S. Moisseiff Memorial Medal to be administered by one of the leading engineering societies, for the award of a medal in the name of L. S. Moisseiff for some outstanding contribution in the field where Mr. Moisseiff was so active. It is estimated that a sum of about $4500 is necessary to establish such a medal. Of this sum $3869 has been raised. Friends of Mr. Moisseiff who desire to make a contribution should make out their checks to the order of the L. S. Moisseiff Memorial Committee and send them to F. Lienhard, 99 Wall St., New York 5, N. Y.

BOOKS AND WORLD RECOVERY

The desperate and continued need for American publications to serve as tools of physical and intellectual reconstruction abroad has been made vividly apparent by appeals from scholars in many lands. The American Book Center for War Devastated Libraries has been urged to continue meeting this need at least through 1947. The Book Center is therefore making a renewed appeal for American books and periodicals—for *technical and scholarly books and periodicals in all fields* and particularly for *publications of the past ten years.* They state that they shall especially welcome complete or incomplete files of THE WELDING JOURNAL.

The generous support which has been given to the Book Center has made it possible to ship more than 700,000 volumes abroad in the past year. It is hoped to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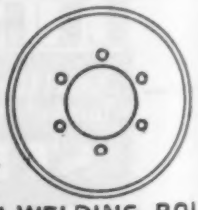
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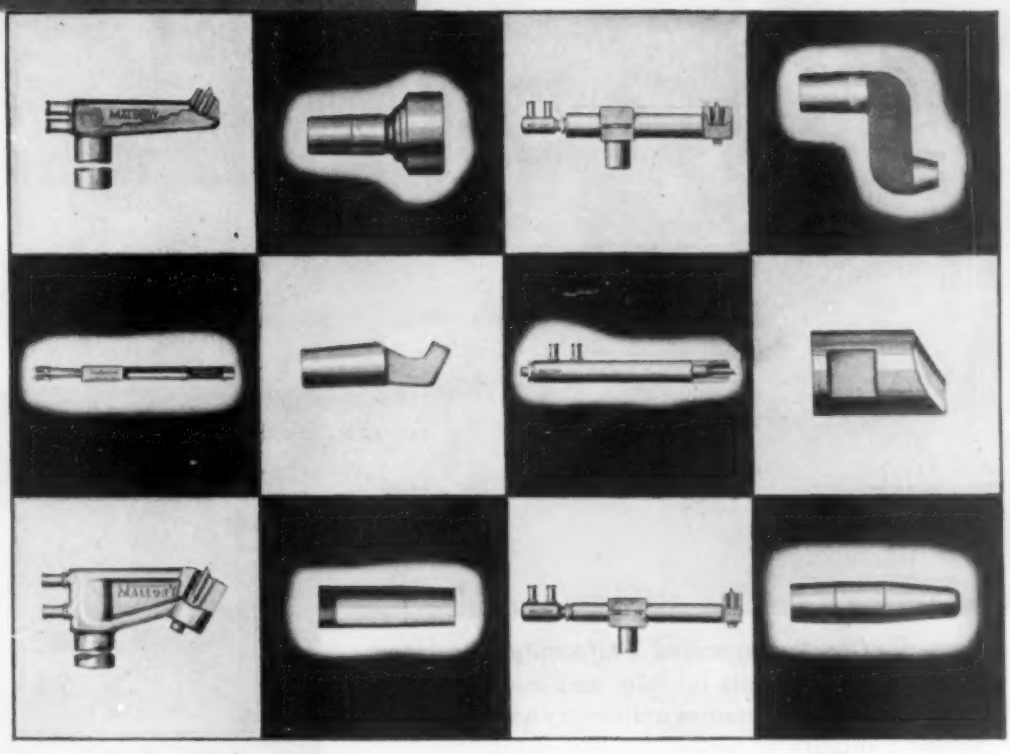
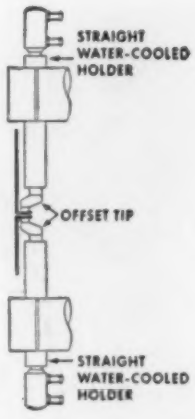
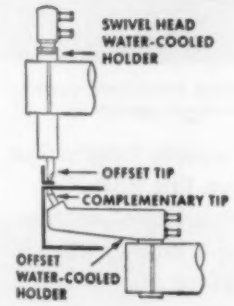
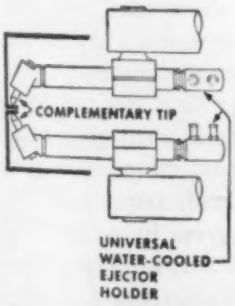
from RESISTANCE WELDING
ELECTRODE HEADQUARTERS





As Many Combinations As There Are Moves In a Chess Game





DO you have a resistance welding job so unusual that you're thinking of having special electrodes or holders made to order? Before you commit yourself to extra time and expense, *take a look at the Mallory Electrode & Holder Catalog.*

Why? Because the Mallory Catalog lists a wide range of resistance welding electrodes—pointed, domed, flat, offset, radius-faced, *Elkonite-faced, threaded, irregular, gun, truncated cone—*all immediately available from stock.* Because water-cooled holders, too, are numerous and diversified (even heavy-duty holders are included)—and are also available for immediate shipment.

What's more, *holders and electrodes are interchangeable,* offering a great number of possible combinations. In fact, it's an exception to find an application that Mallory electrodes and holders are unable to meet. Do you have a copy of the Mallory Electrode & Holder Catalog? A free copy, sent today, will save you time and money.

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ELECTRODES — HOLDERS — SPECIAL DIES AND FIXTURES — ELKONITE*— ALLOY ROD AND BAR STOCK — FORGINGS — CASTINGS — ACCESSORIES
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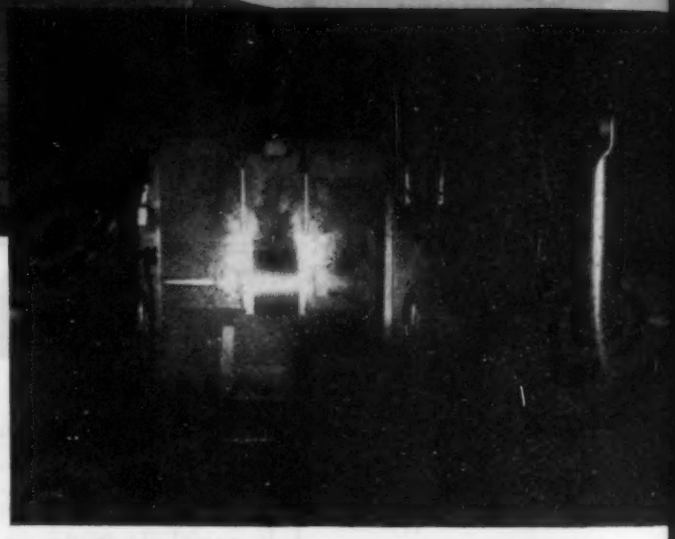
5 REASONS WHY



This specially designed unit, used for welding end seams on refrigerator-compressor seams, helps hold costs down, quality up.

1. *Greatly Increased Uniformity*—Operator sets controls initially and machine *automatically* assures uniformity and improved quality of deposited weld metal.

2. *Increased Speed*—higher welding currents than can be used with manual welding increase arc-travel speed 10% or more.

3. *Duty Factor Practically 100%*—Machine performs tedious work, largely eliminating operator fatigue and sharply reducing "down" time. Operators can be trained more rapidly too.

4. *Reduced electrode consumption*—Coiled electrodes eliminate stub ends, saving average 17% stub-end loss inherent in manual welding.

5. *FASTER, BETTER PRODUCTION* is the ultimate, overall product of these economies (plus such other advantages as reduced set-up time and easier, more efficient handling.)

● If you have a *repetitive* welding operation, calling for volume production, it will pay you to investigate automatic machine-welding fully. (There are half-a-dozen different automatic welding processes.) Such processes are particularly suited to repetitive welding of relatively simple longitudinal or circular seams on a production-line basis.

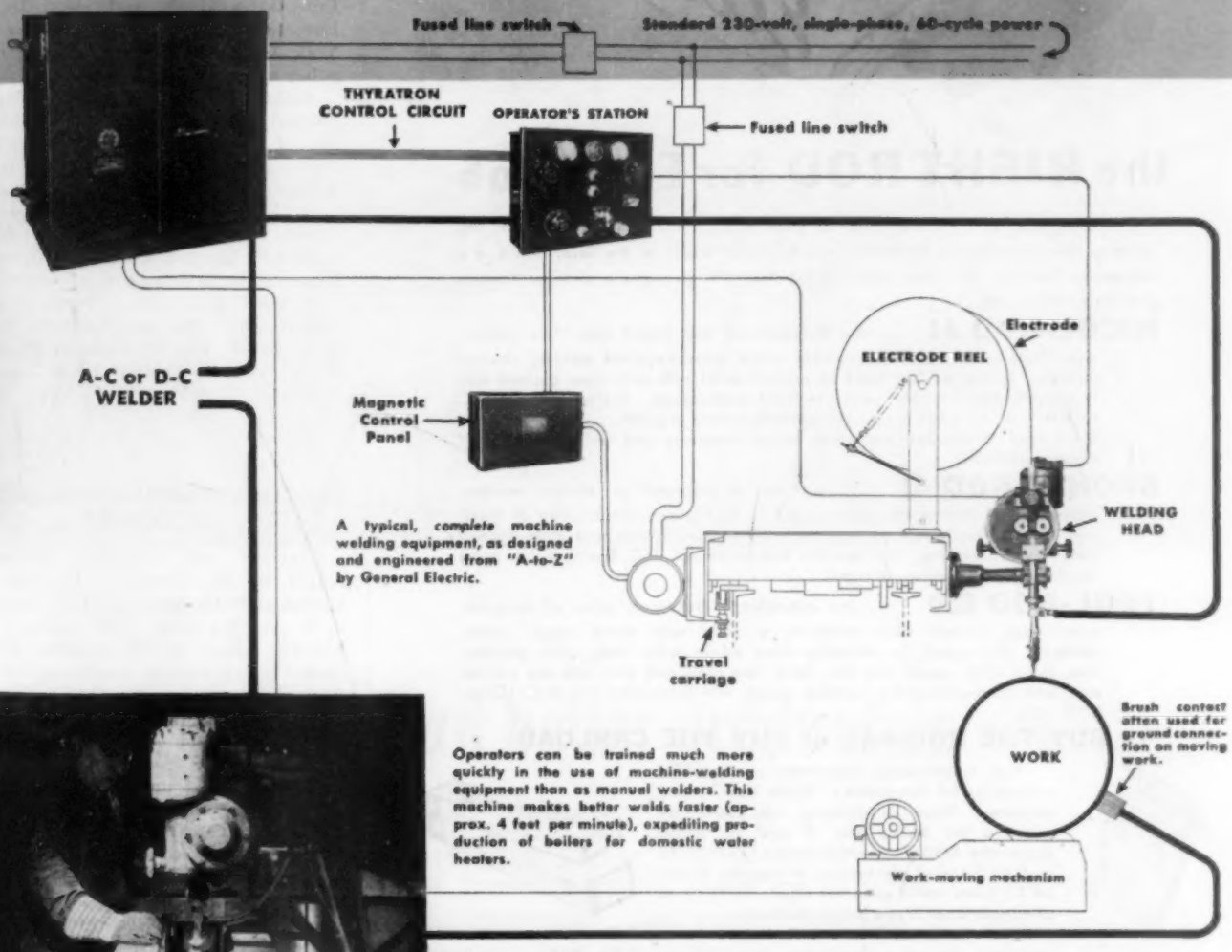
General Electric offers a complete line of machine-welding equipment, including a-c or d-c welders, automatic welding heads*, Thyratron control panels and operator stations, travel carriages, work-moving mechanisms, stick or coil electrodes, and all accessories. Whether your requirements are for a complete, individually engineered equipment, or simply for a welding head, your G-E Arc-welding Distributor will be glad to work with you and supply the necessary equipment, properly engineered and adapted to *your specific* requirements. For information on recent progress in automatic arc welding, write for bulletin GET-1261: *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

* G-E builds five types of automatic welding heads: (1) for Inert-Arc machine welding, (2) for atomic-hydrogen, (3) for metal-arc welding with heavily coated stick electrodes, (4) for metal-arc with heavily coated coiled electrodes, (5) metal-arc with bare or lightly coated electrodes. (No. 5 can be easily adapted for submerged-melt welding—altho G.E. does not supply flux and wire for this process.)

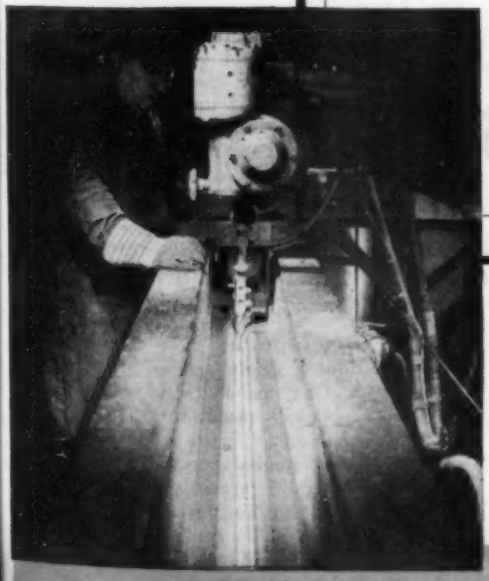
ARC-WELDING EQUIPMENT, ELECTRODES AND ACCESSORIES

AUTOMATIC ARC-WELDING

Offers Greater Economy and Uniformity at Increased Welding Speeds



A typical, *complete* machine welding equipment, as designed and engineered from "A-to-Z" by General Electric.



Operators can be trained much more quickly in the use of machine-welding equipment than as manual welders. This machine makes better welds faster (approx. 4 feet per minute), expediting production of boilers for domestic water heaters.

G-E ARC-WELDING DISTRIBUTORS, in principal cities from coast-to-coast, stand ready to service all your arc-welding requirements, be they for machine or manual welding equipment, electrodes, or accessories. They are also equipped to provide helpful "know-how" in solving your welding problems, in which they are backed up by G.E.'s welding laboratories. See, call or write your nearest distributor today!

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BRONZE-ROD 61 . . . a New development in electric welding pioneered by Marquette Metallurgists. It makes possible brazing of steel, cast iron and malleable castings, galvanized iron, bronze and other copper alloys by arc welding. This versatile Marquette A.C.-D.C. Electrode has good ductility and high tensile strength.

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MARQUETTE WELD-ALL KIT

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WELDING ALLOY MANUFACTURER INAUGURATES AUTHORIZED DISTRIBUTOR POLICY

To meet a sharp increase in demand among many trades and industries for its Eutectic weldrods and electrodes, the Eutectic Welding Alloys Corp. of New York City has recently inaugurated a policy of local distribution.

Authorized distributors are being appointed to handle this nationally accepted line of welding rods and fluxes. Territories are open for established supply dealers each one of whom, according to the manufacturers, will receive the assistance of one of the company's local field engineers in merchandising the line and in handling tough consumer problems.

Further information regarding distributionships may be obtained by writing A. E. Zeisel, Vice-President in Charge of Sales, Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y.

CONCISE CHEMICAL AND TECHNICAL DICTIONARY

Chemical and Technical Dictionary, edited by H. Bennett. Published by Chemical Publishing Co., Inc., Brooklyn 2, N. Y. 6 x 9 in., 1120 pages. Price, $10.00. About 50,000 definitions are included in this volume, which covers every field of scientific and technical development. Written for both professionals and laymen, this book contains a great many internationally accepted terms which facilitate mutual understanding between the scientist and technical worker of many countries.

Practical and easy to use, the nomenclature in this dictionary is that generally adopted by the chemist and engineer. Thousands of helpful cross-references are included, and arranged so that the desired terms can be located with a minimum of effort.

A special feature is an up-to-date compilation of thousands of trade-name or proprietary products in the synthetic resin, plastics, metal, rubber, textile, food, pharmaceutical, paint and varnish fields, including emulsifying and wetting agents, plasticisers, detergents, etc.

The definitions are concise, clear and to the point. Thousands of abbreviations, contractions and many useful tables add to the value of this book

The up-to-the-minute Addenda in the back of the Dictionary lists the newest trade names and definitions of additional technical terms.

PAGE *Welding* ELECTRODES

STEP 1 toward better production welding

"Getting in touch with Page" doesn't always mean ordering a shipment of welding electrodes or rods. Sometimes it means getting some up-to-the-minute information on the right size or analysis of rod—the most efficient welding technique—how some other welder has licked the same kind of problem that comes up in your plant.

Your PAGE distributor is a responsible source for all types of electrodes and rods—specializing in PAGE-Allegheny stainless steel. And if he doesn't know the answer to your welding question, he can get the answer from a PAGE Field Service Man. So we say . . .

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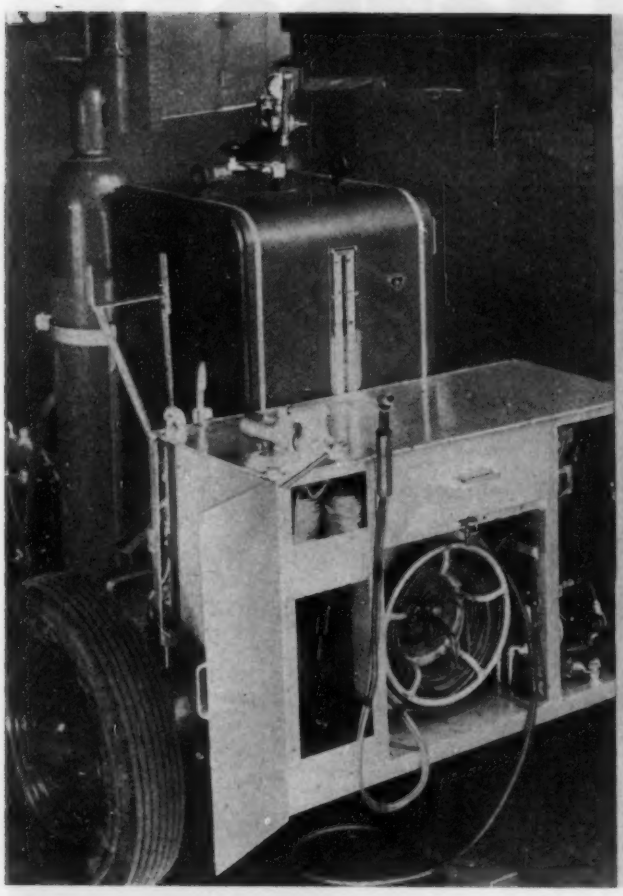
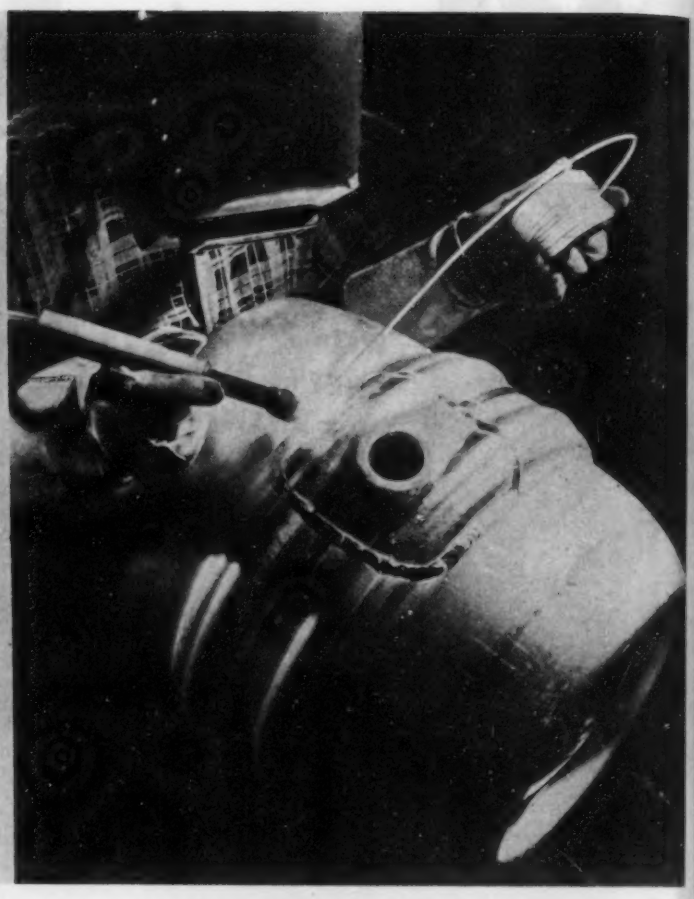
AMERICAN CHAIN & CABLE

TRADE MARK





(Left) Inert Gas Metal Arc Portable Welding Unit Built by the Aluminum Company of America's Jobbing Development Laboratory. This Method of Welding Aluminum Completely Eliminates the Use of Fluxes and Subsequent Cleaning Operations. The Portable Unit Was Constructed to Speed Alcoa's Experimental and Instructional Work, Is the First of Its Kind, and Will Be Used in Plant Construction Welding. The Unit Needs Only Power and Water Connections. The 75 Ft. of Hose on the Center Reel Allows for Extensive Radius of Operation

(Right) The Bung of an Aluminum Beer Barrel Is Being Welded by the Inert Gas Metal Arc Method, Using a Filler Rod

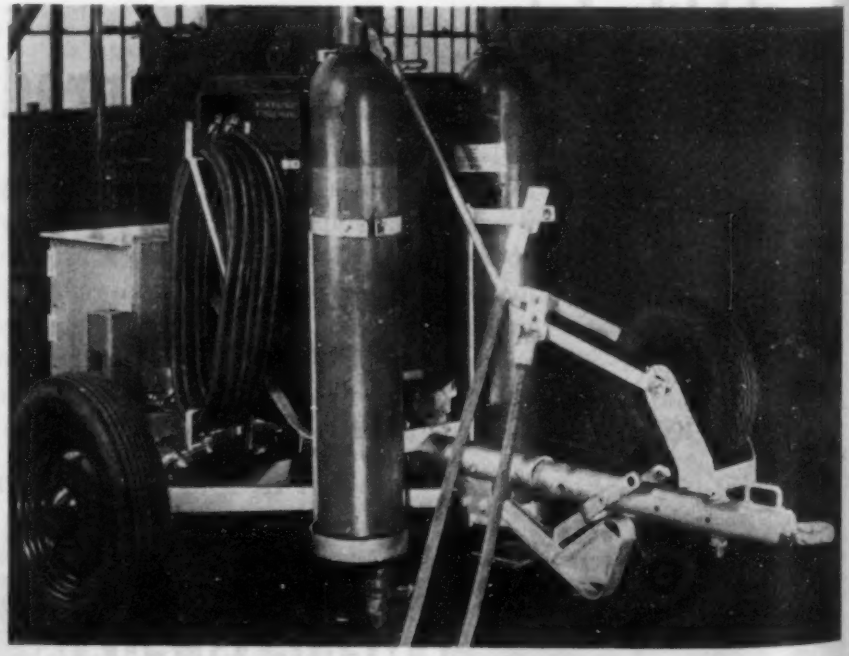
PORTABLE INERT GAS METAL ARC-WELDING UNIT

Inert gas metal arc welding of aluminum has taken to wheels on the portable unit (shown in the enclosed photographs) constructed by Aluminum Co. of America's welding section engineers. Although not intended for outdoor use, the unit was mounted on a road type trailer to facilitate transportation of the equipment between the sites of the several plants where it will be used and to provide mobility at these locations.

The portable welding unit was specifically built for welding aluminum electrical conductors during construction and assembly operations, but it is readily adaptable to other applications. The inert gas metal arc process was selected for making these joints because no welding flux is needed.

This welding process for aluminum consists of drawing an a.-c. arc between a tungsten electrode and the aluminum to be welded. The electrode and the molten aluminum weld pool are protected from oxidation by an envelope of argon gas which is inert to both materials and practically insoluble in aluminum. The high heat intensity of the electric arc permits the joints to be made quickly with a minimum heating. Both the welding torch and its power cable are water cooled.

The three-wheel unit shown in the photographs carries the welding transformer, cylinders of argon gas and connections for the water and drain lines. Electrical control provides protection of the torch against failure of water supply and also starts and stops the argon gas flow and power to the torch.



With the Handtow Wheel Up and Cables Hooked on Their Racks the Portable Inert Gas Metal Arc Welding Unit Is Ready to Be Hooked to a Truck or Other Vehicle for Transporting. The 1,300,000 Circular Mill Aluminum Power Cables Leaning Against the Unit Show Examples of This New Type of Welding

FOR SHIELDED ARC AUTOMATIC WELDING

RACO COMPOSITE TYPE "A"

THE NEW AND REVOLUTIONARY ELECTRODE FOR AUTOMATIC ARC WELDING

RACO Composite Type A is a heavily coated electrode in coils, providing the same physical results as heavily coated manual electrodes. With RACO Composite Type A, extremely high speeds can be obtained in any position.

It can be used with all standard automatic arc welding heads without alterations or additions.

RACO Composite Type A can be had with any of the following coatings—A.W.S. 6012; 6020; 6030 and corresponding high tensile grades. This electrode can also be furnished in three grades of hard surfacing material for building-up—RACO 25 (20-25 Rockwell C), RACO 45 (40-50 Rockwell C) and RACO 55 (50-60 Rockwell C). RACO Composite Type A Electrode is furnished in the following sizes: No. 6 (approx. 1/4"), No. 5 (approx. 7/32"), No. 4 (approx. 3/16"), and No. 3 (approx. 5/32"). Coils are 36 inches I.D., and weigh 150 to 200 pounds net.

LIGHTLY COATED AUTOMATIC ELECTRODES:—

RACO Types "D", "M", M-9 (Knurled), Plain Mill Finish and Copper Coated Wire in coils.

We draw a full line of copper coated oxy-acetylene welding wires. Furnished in coils and straightened and cut lengths.

We further manufacture a complete line of heavy coated manual electrodes for welding:—Mild Steel—High Tensile Steels—Stainless Steel—Manganese Steel—Cast Iron—Nickel—Monel—Inconel and Aluminized Steel.

REID-AVERY COMPANY

INCORPORATED

DUNDALK • BALTIMORE 22 • MARYLAND

SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

Twenty-five-foot torch leads with a 50-ft. extension permit welding in positions and places usually considered almost inaccessible. Although intended for use on aluminum electrical conductors, the portable unit satisfactorily joins aluminum tubing, extrusions and sheet up to 1/4 in. The resulting joints are smooth and bright with ample strength and current capacity.

The unit requires a source of about 20 kva. of 440 or 220 v. 60 cycles power, and a source of clear, cool water of 1/2 gal. a minute at 50 psi.

HOTEL RESERVATIONS 1947 ANNUAL MEETING

The 1947 Annual Meeting of the Society will be held October 19–24 at the Sherman Hotel, Chicago. As usual, this Meeting will convene during the National Metal Congress and Exposition and with the large attendance at the simultaneous meetings it is important that hotel reservations be made as early as possible.

The Sherman Hotel has reserved 600 rooms for members of the Society, including 150 single rooms and 450 double rooms with twin beds, and, in addition, 9 suites.

EXPANSION OF INDUSTRIAL RESEARCH

Expansion of research by industry and an immediate shortage of trained personnel for industrial and scientific research were foreseen by Dr. A. B. Kinzel, chairman of the Board of the Engineering Foundation, in the Foundation's 32nd annual report to the Board of Trustees, made public recently.

The shortage of research personnel will be relieved, Dr. Kinzel predicted, as more students undertake graduate work in universities which at present are inadequately staffed because of competition for trained men by Government and industry. "It is clear that industry has, in general, become more research minded and large expansions of industrial research are to be expected," he said. "In some cases this will be by individual companies, in others, by associations of various types."

Sixteen Projects Sponsored

Sixteen projects were sponsored by the Engineering Foundation during the past year, six of which were carried over from the preceding year. Among projects in the various fields of engineering were: soil mechanics, with particular application to foundations; fluid mechanics, with particular application to hydraulics and to principles underlying operation of turbines and compressors; materials of engineering, comprising such researches as alloys of iron, stability of steels as affected by temperature, plastic flow of metals, and strength of metals; welding; lubrication; and rolling friction.

The Engineering Foundation, whose offices are in the Engineering Societies Building, 29 West 39th St., is a department of United Engineering Trustees, Inc., and was established jointly by four national engineering Founder Societies in 1914. In addition to sponsoring research in various fields of engineering, it also supports agencies or activities having as their objectives the advancement of the engineering profession. Among the latter is the Engineers' Council for Professional Development, a cooperative effort of eight national engineering organizations to raise professional standards of education and practice.

In the current report, grants were recommended for the continuation of nine projects and the support of four new ones.

Research and Application in Various Fields

Research in Soil Mechanics included tests to show how the soil behaves under pressure, due to weight of buildings. Resultant data will enable engineers to design more surely safe and economical structures. This work is still under way at Northwestern University, under the direction of Professor J. O. Osterberg, Research Engineer.

"Hydraulics of Manifolds," a research project under the direction of Professor John S. McNown of the University of Iowa, is directed toward a clarification of the basic principles governing flow in manifolds. Such principles would be of value in designing port systems in navigation locks and penstocks, for instance. During the past year the first phase of the study was completed.

Related research has gone on at Ohio State University under the leadership of Professor S. R. Beitler to devise instruments for measuring the flow of liquids and gases when the flow is not uniform but pulsating. The war limited research on this problem which has never been completely solved, the report stated.

The Engineering Foundation helped foster research for material used in an important reference book on fluid dynamics, as applied to turbines and compressors, compiled by Dr. John R. Weske, Professor of Aerodynamics at Purdue University. It also had a part in the study of mechanical springs which resulted in a book "Strength of Metals," by Dr. D. J. McAdam, Jr., and R. W. Clyne of the U. S. Bureau of Standards, to be published soon.

Alloys of Iron Research, a project established in 1930 to compile and publish data on iron alloys, was re-established last year after a period of inactivity during the war. It is now preparing, under the direction of Frank T. Sisco, the first of a series of books concerning the advances in ferrous metallurgy made during the war.

Findings Vital to Industry

Studies on the stability of carbon and alloy steels at high temperatures over long periods of time were supervised by J. J. Kanter, Materials Research Engineer of the Crane Company, Chicago. The importance of this project was felt acutely by the power industry when it was found that graphite had formed in welded steel piping operating at steam temperature. Steel producers, and fabricators and operators of power plants, as well as the public, are concerned with the outcome of this research being carried on at the Crane Company; Philadelphia Electric Company; General Electric Company, Schenectady; Battelle Memorial Institute, Columbus, Ohio; and the Detroit Edison Company.

An attempt to determine what happens to metals in rolling and drawing, processes widely employed in industry, is included in research on plastic flow of metals. Under the direction of Dr. A. Nadai of the Westinghouse Research Laboratories, this work was carried out at Massachusetts Institute of Technology and the Case School of Applied Science.

The effect of high pressures on the viscosity of lubricants was examined by a project headed by Dr. B. L. Newkirk, Department of Aeronautical Engineering, Rensselaer Polytechnic Institute.

Studies to determine energy losses due to rolling resistance in certain typical cases were conducted by M. D. Hersey at Massachusetts Institute of Technology. Results could be applied, for example, to the deceleration of mine car wheels coasting on straight track or rolling around curves, carrying loads of various weights.

Under the direction of W. Spraragen, the Welding Research Council continued its work of analyzing problems involved in the design, fabrication and service performance of all kinds of welded structures used in industry. It has published some 70 critical digests of literature on welding which comprise the best reference library in this field. Research facilities, personnel and literature of the Council were used extensively by the Government during the war years.

Initiated late last year was participation in a project that will be carried out by expert personnel "detailed" to the U. S. Department of Commerce. The purpose is to investigate and evaluate German developments during the war years in scientific personnel management and industrial training.

Other projects sponsored by the Foundation during the past year include the Column Research Council, Research Council on Riveted and Bolted Structural Joints, Metal Cutting Data, and the Engineers' Council for Professional Development.

TAKING THE MEASURE OF METALLIC GRAINS

A contribution to the search for better metals and by-products of his metallurgical studies is the new grain size comparator developed by F. C. Hull of the Westinghouse Research Laboratories. Consisting of a ground-glass screen hinged to an illuminating unit with a slotted wooden frame, it is easily attached to a standard metallograph. It provides for counting the grains in a certain area or estimating their extent by comparison with a series of standard photographs.

To determine the grain size of a particular specimen, a polished and etched sample is placed on the stage of the metallograph and projected in magnified form on the glass screen. Its granular boundaries can be seen in clear, maplike form. A transparent slide of a known, standard grain structure is slipped into the wooden frame and illuminated by incandescent light. The magnifying power of the metallograph is then changed by extending the bellows until the unknown image matches the grain size of the standard. The amount of adjustment needed is read from a scale on the metallograph, and grain size

The ELECTRODES you need are in this McKAY CATALOG

When you want electrodes for fabrication or maintenance welding, turn to your copy of the McKay Electrode Catalog. Its Quick-Reference Guide makes it easy to find the *exact* electrode for every welding application.

Clear, concise and up-to-date—this manual is organized to give you complete specifications, operating characteristics, mechanical properties and other pertinent data on all types of McKay Mild-Steel Electrodes.

In addition, a section is devoted to the newly developed McKay Pluralloy Electrodes for welding *hardenable* low-alloy, high-tensile steels . . . and other "Special-Purpose" Electrodes designed for welding steels which are usually difficult to weld.

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of the unknown specimen determined by reference to a standard graph.

The grain structure of metals is a most revealing clue to their qualities. Relatively large grain size may produce superior rupture and creep strength, whereas in the same metal fine grain structure may give greater tensile strength, ductility or endurance. Knowledge of controllable grain size is vital "evidence" in metallurgical problems.

RADIOGRAPHY

A new book published by the Eastman Kodak Co., Rochester 4, N. Y., "Radiography in Modern Industry" is the most complete and authoritative treatment of this subject which has yet been published.

This book is the work of a number of people both in the Kodak Research Laboratories and in the Industrial X-Ray Division, augmented by reports of this company's field representatives who serve as first-hand consultants to industries using radiographic techniques. Manufacturers of X-ray equipment assisted in the preparation of this book.

The retail price of the book is set at three dollars and available through Kodak X-ray dealers.

STUD WELDING

A variety of applications of high-speed stud welding are described in a new 36-page brochure just published by the Nelson Sales Corp., Lorain, Ohio, distributors of Nelson stud-welding guns and flux-filled studs.

Operating principles of the 5 lb. gun—which, connected to a standard welding generator is capable of applying up to 30 studs per minute—are included in the booklet, as are detailed studies of applications of a wide range of standard and specialized studs.

Illustrated with both diagrams and photographs, the booklet also tabulates complete specifications and physical properties of standard studs. Copies are available on request to Nelson Sales Corp., Lorain, Ohio.

"FINISHES FOR ALUMINUM"

Aluminum offers many valuable and interesting combinations of surface finishes for enhancing its appearance. To indicate some of the important possibilities, Reynolds Metals Co. has published *Finishes for Aluminum* in two volumes.

The first book Section One, is wire bound and contains 108 pages devoted to 8 cleaning treatments, 17-mechanical surface finishes, 15 chemical surface finishes, 11 electrolytic oxide treatments, 12 electroplated coatings, 7 paint application methods, 7 paint coatings, ceramic coatings (vitreous enamels), special finishes such as silk screen and sprayed metal finishes, and concludes with a discussion of various controls and tests for finishes.

The second book, Section Two, supplements this information with 120 pages of shop data on materials, equipment, solution preparation, procedure and control for more than 30 of the most widely used finishing processes. This book is supplied in a separate loose-leaf binder and new and revised bulletins will be issued at intervals to keep this information up-to-date.

Reynolds *Finishes for Aluminum* (two volumes) thus supplies to users of aluminum a complete and continuing service unique in the finishing field. It offers an effective means of keeping up with the many advances being made in this phase of aluminum processing. Copies are available from Reynolds Metals Co., Dept. 27, 2500 S. Third St., Louisville 1, Ky. Price $2.00.

SPECIFIC-GRAVITY INSTRUMENT TESTS

Tests of Instruments for the Determination, Indication, or Recording of the Specific Gravities of Gases, by Francis A. Smith, John H. Eiseman and E. Carroll Creitz. At the request of the American Society for Testing Materials, the National Bureau of Standards completed in 1941 a critical study of instruments available to industry for the determination, indication or recording of the specific gravities of gases. Instruments were submitted for test by all interested manufacturers. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price, $1.00.

SEAMLESS WELDING FITTINGS

Ladish Co. of Cudahy, Wis., producers of Ladish forged steel fittings and forged steel flanges, have introduced a new line of controlled quality seamless welding pipe fittings.

Already being stocked by authorized Ladish distributors in principal centers, the new line consists of 90° and 45° elbows, 180° return bends, straight and reducing tees, concentric and eccentric reducers, caps, lap joint stub ends, saddles, shaped nipples, crosses and tees in carbon steel, sizes up to 30 inches.

Features inherent to the complete line of Ladish seamless welding fittings include uniform wall thickness, accurate circularity, full effective radii, smooth inner walls machined bevel-ends and improved metal structure.

While designed and manufactured in accordance with recommendations of the American Standards Association and other standards, Ladish seamless welding fittings have many distinctive features, chief among which is a new tapered tee design. Achieved through scientific metal distribution, the center sections and the crotch are reinforced, the metal tapering off to nominal pipe size at the ends. This new application of the taper principal has resulted in a tee that provides greater strength and durability under severe operating conditions.

In addition to the new tapered design, Ladish tees have a long inner crotch radius which reduces friction and turbulence, thus minimizing pressure loss. Full length branch outlets facilitate the welding operation.

A 10-page folder, giving dimensions and approximate weights, is available upon request.

NEW LOS ANGELES PLANT OPENED BY HANDY & HARMAN

Open house and luncheon were the order of the day on March 11th as Handy & Harman opened the doors of their new West Coast service plant.

The new headquarters are located at 3625 Medford St., Los Angeles 33. They will house the Sales department and manufacturing facilities for users of precious metals. All of the company's products, including silver brazing alloys and fluxes sterling silver and karat gold sheet and wire, silver anodes, sterling and fine silver grain will be produced at this plant. A complete refining service is included for recovering precious metals from scrap and waste.

The new plant will operate with H. A. Folgner as manager. It is the company's fifth plant, others being located in Bridgeport, Conn., New York, N. Y., Providence, R. I., and Toronto, Canada.

WELDING AND FLAME CUTTING IN THE MINING INDUSTRY

This 16-page article reprint covers the application of the electric arc and the oxyacetylene flame in the mining field. Illustrated with nearly 40 photographs, the article stresses repair, rebuilding and fabrication of mining equipment.

Copies of this informative article may be obtained by writing Air Reduction, 60 E. 42nd St., New York 17, N. Y. or the Airco sales office nearest you.

OBITUARY

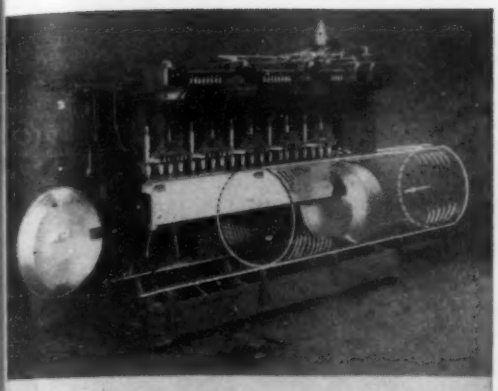
William O. Aldrich

William O. Aldrich died quite suddenly of a heart attack on January 11th. Bill Aldrich, as he was affectionately called by everyone who knew him—was beyond all question one of the most perpetually young men in the welding industry. His enthusiasm was as boundless as was the circle of his friends.

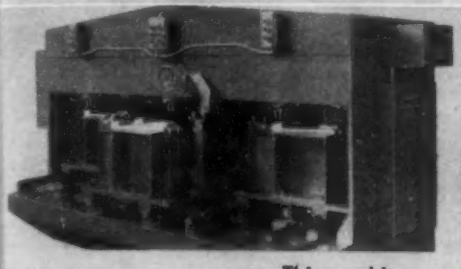
He entered the welding industry via Metal & Thermit Corp. in the New York territory in 1909. Later he was transferred to his company's Southern Division, and in 1922 arrived in San Francisco where he became District Sales Manager, Thermit Division, South San Francisco Calif.

Bill did not need much time to get acquainted because in that same year he managed to be one of the founders of the San Francisco Section of the AMERICAN WELDING SOCIETY.

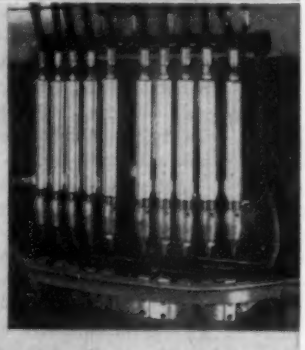
A man who enjoyed his work, enjoyed the industry in which he operated, enjoyed people, and in his lifetime achieved a great deal.



Welds 3 sizes of shells for water heaters, from rolled sheet. Straight line production. 20 guns index automatically to make 40 welds. Five twin-secondary transformers. Automatic sizing (by cones); automatic clamping and unloading (left cone is air operated). Right cone and guns adjustable for different lengths.



This machine can bat out 300 steel drawers per hour in 3 sizes. Twelve welds per drawer. Three twin-secondary transformers. Automatic clamping and shuttling.



Welds fender skirts in front fenders with 10 simultaneous welds. Three twin-secondary transformers.

IT PAYS TO WELD

PROGRESSIVE Welder Co.

3050 E. OUTER DRIVE • DETROIT 12

RESISTANCE WELDING EQUIPMENT

The low-down on MULTI-TRANSFORMER MULTI-SPOT WELDERS

Progressive multi-transformer machines are "tops" when it comes to extremely high production. This is due to:

1. **Simultaneous spot welding (10 to 30 welds per sec.).**
2. **Simplicity of design means low maintenance.**
3. **Flexibility. See examples at left.**
4. **High efficiency. Short cables. Number of simultaneous welds adjustable to power supply.**
5. **High salvage. Just change dies and relocate guns for a new job or different size part.**
6. **Avoids complete shut-down in case of trouble with any one transformer-gun group.**

Progressive's Process Engineering Department can help you obtain lowest overall cost per piece.

To Design Engineers—

In designing sheet metal parts for fast assembly on Progressive Multi-Transformer machines, remember to:

1. **Space welds at least 1¾" apart whenever possible to allow room for guns.**
2. **Where closer spacing is desired, locate welds in patterns (straight lines, curves, etc.) so that the guns can be automatically indexed singly or in groups to obtain required spacing.**
3. **To take full advantage of machine speed, design parts for quick loading. Where possible, provide for pre-loading of subassemblies.**

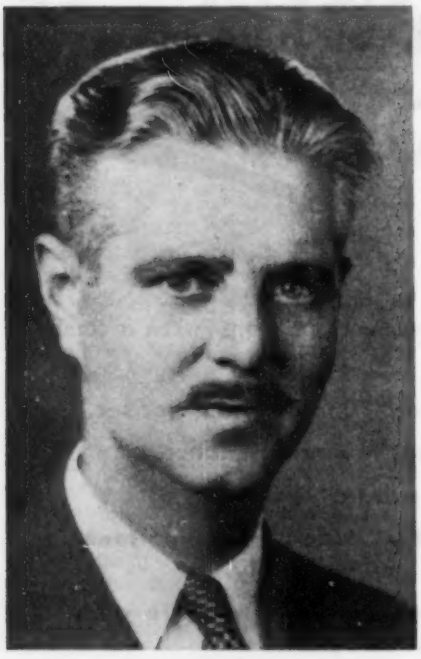
Progressive's Process Engineering Department will be glad to help you design for lowest overall cost per piece.

CABLE ADDRESS "PROGWELD"

MEMBER RWMA

AIRCO NAMES BOLLINGER DISTRICT SALES MANAGER

The appointment of J. G. Bollinger as District Sales Manager of Air Reduction has just been announced by Harold P. Etter, Sales Manager, Pacific Coast Division.



J. G. Bollinger

Mr. Bollinger served in the Armed Services during World War II with the Aviation Engineers in the Hawaiian Islands and on Guam and rejoined Airco last July.

He has had more than twenty years' service with the company and in his new capacity will report to Hal W. Saunders, Manager, San Francisco District, with headquarters in the new Air Reduction offices at 1485 Park Ave., Emeryville, Calif.

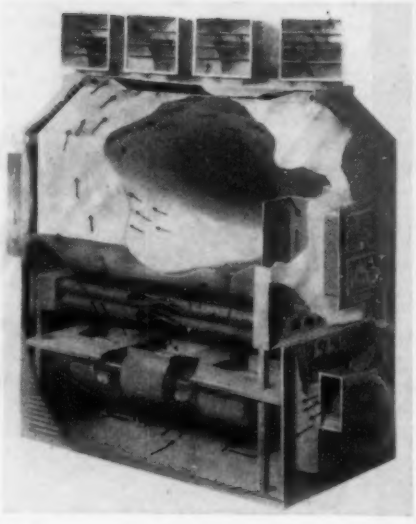
STAINLESS STEEL HEATER

Development of a welded stainless steel combustion chamber for its commercial and industrial direct-fired heater has just been announced by Dravo Corp., Pittsburgh.

By using this material for combustion chambers, Dravo engineers assert that the life expectancy of these heaters has been greatly increased since stainless steel has such high resistance to oxidation.

While stabilized stainless steel has been used in high-temperature work, such as ducts for direct-fired turbines, this is believed to be the first time it has ever been incorporated in commercial and industrial space heaters. The vulnerable part of an air heater is the combustion chamber where oxidation from high temperatures may cause inefficiency and failure. The application of heat-resisting steel in the Dravo Counterflo Heater not only will prolong its useful life, but will aid in maintaining high efficiency.

Refractory lining, which has always been considered necessary with carbon steel chamber construction, is completely eliminated in the new type. As a result, it is lighter in weight and more compact in size, making possible a much wider range of application. For instance, suspended heaters may be located in the building roof trusses, either vertically or horizontally, depending on the head room.



Assembly line production technique and part of the manufacturing facilities devoted to the construction of LST's during World War II has made these Dravo heaters available for prompt delivery. They can be used by building contractors to provide temporary heat during construction and later moved to permanent positions in the finished structure. Installation is very simple, requiring only fuel line, power line and vent stack. They can be arranged to utilize either gas or oil as fuel, and can be converted readily from one to the other.

MICROHARDNESS OF STEEL

The hardness, not only of a piece of steel you may feel in your hand and examine with your naked eye, but of microscopic grains within the steel, can be measured by a new device designed at the Research Laboratory of United States Steel Corp. of Delaware. Still more minutely, the new microhardness tester can gage the hardness of a single steel grain at as many as three points within the breadth of a human hair.

By no means an instrument of abstract research alone, this tester is in continuous use at the Kearny, N. J., Laboratory, perfecting studies of the microscopic constituents of steel. The results of these studies are coordinated to develop steels of definite hardness and toughness for specific applications in the home and factory, on railroads, ships and planes, and in the American family's automobile.

Like the Brinell, Rockwell, Vickers and other traditional hardness testers, but on a much finer scale, the Kearny device operates by indenting the polished surface of a steel sample. Its diamond-point penetrator under a load of a very few grams leaves a square mark which can rarely be seen by the naked eye. The diagonals of this tiny square indentation are measured in microns, or thousandths of a millimeter, and this reading related to the load placed on the penetrator so that hardness may be computed.

Preparation of the sample of steel whose hardness is to be measured requires elaborate care. A small sample, which may be mounted in plastic, is ground and finished with polishing paper, care being exercised so the grinding effect does not extend below the surface. Then it is polished on wet lead laps. Alternately the sample is polished to a mirror finish with a soft abrasive so finely divided that when shaken in water it will take a half hour to settle and lightly etched with acid to bring out the grain boundaries. This dual process is continued until no disturbed metal is observed under the microscope.

Fig. 1

Destined to gleam unseen is this tiny diamond used to test the hardness of microscopic grains of steel in the Research Laboratory, United States Steel Corp. of Delaware, Kearny, N. J. The pyramidal gem has a square base and is minutely cut to a 136° angle. Its wedge point is capable of making three indentations within the breadth of a human hair, hardness of steel being measured microscopically by the length of the diagonals of the impression.

The operator of the microhardness tester then places the sample under the microscope on a movable bed plate and selects the grain or area to be tested. When this is determined the sample is transferred to the penetrator mechanism. The penetrator arm, balanced with its adjustable weight suspended on knife edges, slowly bears down its weight to make the indentation.

After the indentation has been made the sample is moved back under the microscope and examined. Depending on the sample, identations may range upwards of 2 microns in depth, which is proportional to the diagonal of the square identation. This is measured in microns. One micron equals roughly forty-millionths of an inch. The device makes possible the measurement of hardness gradients within areas too small to permit satisfactory exploration with any of the usual hardness testers.

The microhardness tester measures with amazing accuracy the hardness of the hardest steel constituents. This is necessary to know the degree of hardness of steel grains themselves, and of the iron and other alloy carbides. The mechanism consists of the indenter with a square-base, 136-degree diamond pyramid penetrator, the mechanical stage for holding the specimen, a microscope capable of magnifying the test field 500 to 1500 times and a control box. All parts are assembled on a heavy cast-iron plate supported by steel legs which rest on insulated wooden blocks

"Half-inch or Thirty!"

You don't do much shopping around for the fittings you need when you deal with the Tube Turns distributor. He's got 'em or can get 'em for you, fast—welding elbows ranging in diameter from tiny half-inch to a mighty thirty inches, welding fittings of all types and thicknesses in a wide range of sizes.

Tube Turns' complete line of TUBE-TURN welding fittings and flanges in grade A and grade B carbon steels contains more regularly manufactured items than any other line—more than 4,000! And this is supplemented by an extensive selection of items in a wide range of special metals and alloys —stainless steels, carbon moly steels, chrome moly steels, copper, aluminum, brass, monel metal, inconel, nickel, wrought iron.

Write for the name of your nearest Tube Turns distributor, and for facts about how the fittings that become part of the pipe serve others in your industry.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY

District Offices at New York, Washington, D. C., Philadelphia, Pittsburgh, Detroit, Chicago, Houston, San Francisco, Los Angeles

TUBE-TURN TRADE MARK **tt** *Welding Fittings and Flanges*

ONE SOURCE OF SUPPLY FOR ALL WELDING FITTING REQUIREMENTS

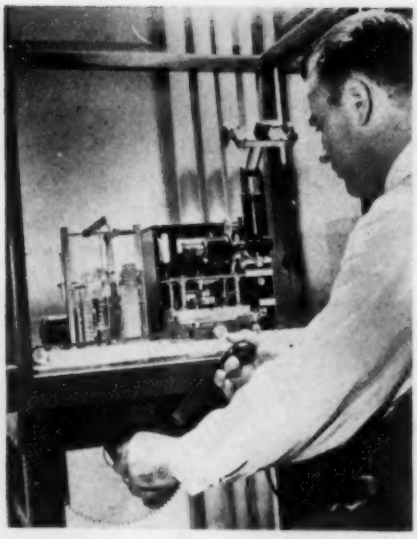


Fig. 2

Microhardness tester perfected by scientists of the Research Laboratory, United States Steel Corporation of Delaware, Kearny, N. J., operated by a staff member, aids in the development of steels of definite hardness and toughness for specific applications in the home and factory, or railroads, ships and planes, and in the American family's automobile. The tester comprises a penetrating unit (left) and a mechanical stage (right) equipped with a microscope capable of magnifying the steel test field 500 to 1500 times. Hardness is measured by the diagonals of a diamond-made penetration in terms of microns, each roughly equaling forty-millionths of an inch.

to minimize effects of vibrations present in the building. As many as 60 indentations may be made automatically at predetermined time intervals for surveying tiny gradients, which may have an important influence on the behavior of a fabricated product such as a weld.

PROJECTION WELDING OF CABINET LATCHES

Projection welding—coupled with a simple holding fixture specifically designed for the particular operation—has enabled Dedoes of Berkley, Mich., to not only reduce the time required to assemble its

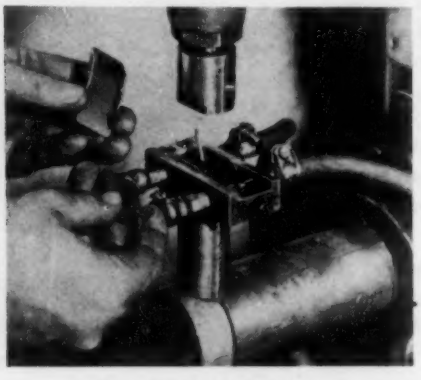


Fig. 1—Photo of Fixture

This simple fixture holds both parts in a standard 50-kva. Progressive pedestal welder. Upper die holds the trigger cam by automatic spring clamping. The lower die has a plain recess for locating the finger plate.

Fig. 2—Sketch of Completed Latch

Fig. 3—Sketch Showing Angle of Joining Trigger Cam to Trigger Plate

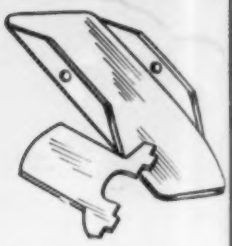


Fig. 4—Sketch of Trigger Cam to Show Two Projections

Original design for flush latches for kitchen-cabinet doors and drawers as developed by Dedoes of Berkley, Mich.

Trigger cam must be attached to finger plate at an acute compound angle, without marring the front of the plate. Joining at first was by silver brazing, a rather slow and costly process.

The trigger cam is provided with these two small projections for projection welding in the fixtures.

kitchen latches but also to cut assembly costs materially. All dies and machines were designed and produced by Progressive Welder Co. of Detroit.

Dedoes had developed an original design for flush latches for kitchen-cabinet doors and drawers (Fig. 2). Assembly of the latches presented one difficulty, however. The stamped trigger cam has to be attached to the formed trigger plate at an acute compound angle, as shown in Fig. 3. Moreover, the assembly method has to be such that no surface markings will be left on the front of the finger plate.

As a result, Dedoes assembled the part by silver brazing. This was rather slow and costly, however. Efforts to obtain resistance welding equipment for the job met with the answer that this was impossible unless costly and complex expanding or collapsing dies were employed.

The problem was finally turned over to the Process Engineering Department at Progressive Welder Co., Detroit, who designed a simple fixture, shown in Fig. 1, for holding both parts in a standard projection welder. This made possible the joining of pieces by projection welding on a standard 50-kva Progressive pedestal welder, while allowing rapid loading and unloading of parts without manual clamping or unclamping. The upper die holds the trigger cam by automatic spring-clamping. The lower die has a plain recess for locating the finger plate. This permits straight-line retraction of the welded assembly by the upper die, eliminating need for special collapsing dies.

The trigger cam, of course, was provided with two small projections (see Fig. 4). There is no marring of the finger plate. Production is 600 units per hour. Cost of joining parts is about one-quarter of the cost when using silver brazing. In addition, less operator effort is required.

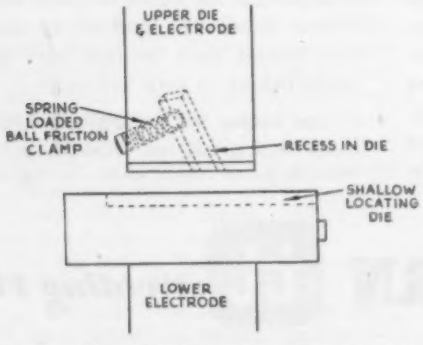


Fig. 5—Sketch Showing Principles Used in the Die

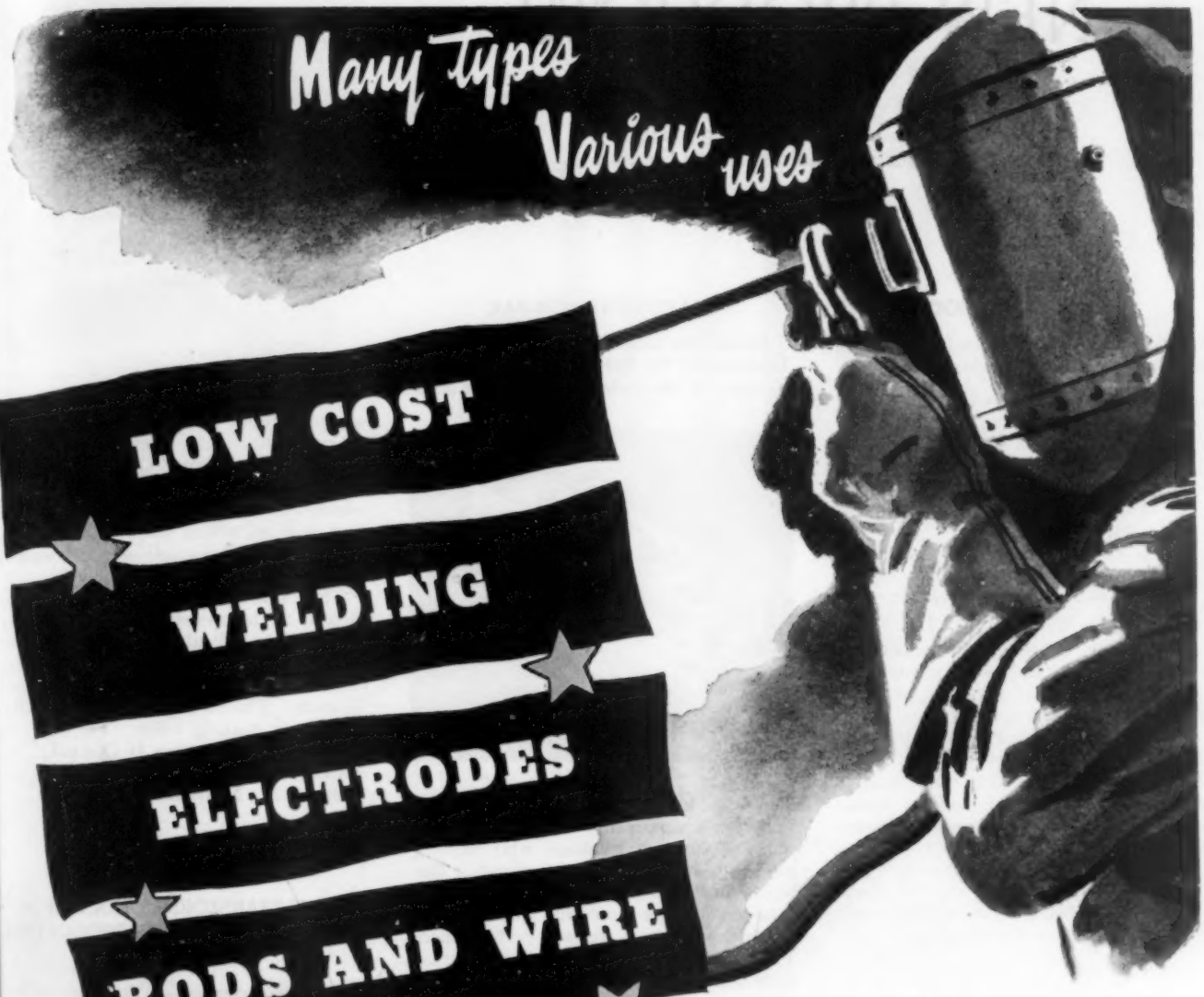
HOLCOMB NEW P&H SALES MANAGER

Harnischfeger Corp. of Milwaukee, builder of P&H products, has announced the appointment of Ralph D. Holcomb as General Sales Manager. He will direct the sales of all P&H products, excavators, road machinery, hoists, cranes and welding equipment.

R. D. Holcomb

Mr. Holcomb's elevation to his new post follows 18 years of continuous service with the P&H organization. During this period, he has directed sales in many sections of the country, including Wisconsin, New York, Pennsylvania, Missouri, Tennessee, and, finally, California, his latest position being that of District Manager for the San Francisco territory.

In addition to his long experience in field activities, Mr. Holcomb also served as Sales Manager of P&H's Large Excavator Division from 1940 until 1942.

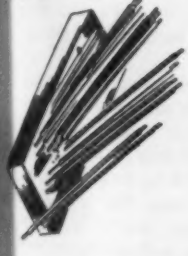


LOW COST WELDING ELECTRODES RODS AND WIRE

Here is your opportunity to build up needed stocks of Welding Rods, Electrodes, and Welding Wire! Over $3,000,000 worth of this equipment is immediately available at low WAA prices. Act now to get as much as you need. Most WAA Regional Offices have an inventory—write, wire or phone the one nearest you for complete information.

WELDING ELECTRODES

Various types for use in electric arc welding of ferrous and non-ferrous metals. Diameters range from 3/32" to 3/8", in 14" and 18" lengths packed in boxes.



WELDING RODS

Various types for use in either gas or electric arc welding of both ferrous and non-ferrous metals. Various diameters, from 3/32" to 3/8" in 36" lengths, available in boxes or packages.

EXPORTERS! Your business is solicited. Much material which is surplus in the United States is urgently needed or is readily salable in other countries. Watch for other offerings, many of them may be of interest to your clients.

Have your name put on the mailing list to receive further offerings of welding rods.

NEED WELDING WIRE?

You can get a quantity of low cost high quality standard welding wire in wrapped coils. Simply contact the WAA office nearest your location, and order now the wire you need.

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WAR ASSETS ADMINISTRATION

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1106-A

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

NEW WELDING RODS

Eutectofilm is applied to bare welding rods and gives the following advantages:

1. It improves the welding characteristics of the rod.
2. It insures the obtaining of high physical properties in the weld deposit.
3. It assists in surface alloying at low base metal heats.
4. It protects the filler rod from corrosive attack which would have detrimental effect on weld metal and its flow.

After being subjected to exhaustive tests, Eutectofilm has been adopted by Eutectic and is now standard on most EutecRods (for torch applications).

The Eutectic Welding Alloy Corp. also announces a new type of welding rod which requires less heat and can be used successfully on cast iron, steel, copper, brass, aluminum, zinc die castings and for overlaying.

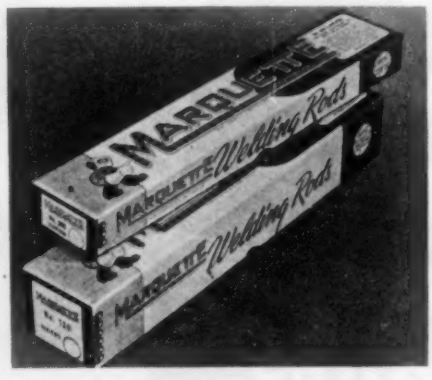
A card addressed to the Eutectic Welding Alloys Corp., 40 Worth St., New York 13, N. Y., will bring additional information about these new developments.

ALUMINUM FLUX

All-State Welding Alloys Co., Inc., 96 West Post Road, White Plains, N. Y., announces the immediate availability of a new aluminum flux for brazing sheet aluminum. This flux has a low melting point of around 950° F. and becomes quite active at 1000° F. Unlike most other fluxes, it breaks down into a completely liquid state and gives excellent capillary action to the aluminum brazing alloy. If the parts that have been welded are submerged in hot water while still hot, nearly all traces of the flux are removed. Also, unlike other fluxes of this type on the market, this flux leaves little trace of any flux residue on the work. The work is left without any noticeable dark areas, which characterizes other aluminum fluxes. One other feature of this flux is that in its wetting action during the preheat period it goes from a powder form directly or into a clear liquid, which helps carry the brazing alloy along the seams of the joint to be welded. Other aluminum fluxes start breaking down to the liquid state, but leave unmelted granules of flux which retard the flow of the brazing alloy. This flux may be used with All-State No. 31 sheet aluminum brazing rod in the brazing of all types of sheet aluminum. It is known as All-State No. 31A flux.

MARQUETTE ROD-PAK

Marquette Manufacturing Co., Inc. of Minneapolis 14, Minn., is now packaging 17 types of electrodes in all popular sizes.



The new Marquette ROD-PAK 5 and 10 Pounders are especially designed for maintenance and repair shops who need a moderate supply of all types of rods. The handy new Marquette ROD-PAK makes it easy to always keep a full stock of fresh electrodes for best welding performance. Type and size of rod are clearly printed on both ends of ROD-PAK for instant identification.

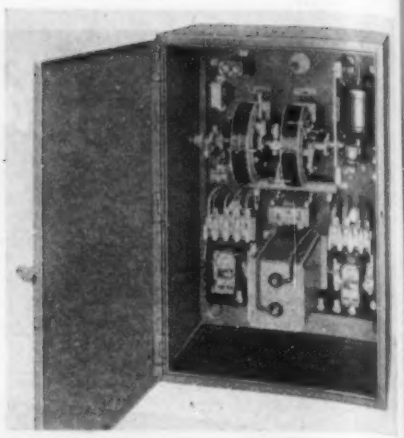
TIMER FOR GUN WELDER CONTROL

This new fully automatic control, recently introduced by the Industrial Controller Division of the Square D Company, is designed specifically for gun-welder applications to obtain the maximum speed and performance from the tool and associated air system. This timer may be used to particular advantage for sheet metal fabrication where production line techniques are applied; for example, in automobile body fabrication.

Identified as Class 9052, Type FG, this new timer is composed of a synchronous motor-driven cam shaft, two control relays, low-voltage transformer and capacitor braking circuit consisting of large condenser, reactor and resistor. All components are mounted on an ebony asbestos panel with terminals for external connections mounted near the bottom of the panel.

Squeeze Delay Is Important Feature

Often an operating stroke of several inches is necessary to clear projections or obstructions over which a tool must pass in reaching the welding position. This means a long squeeze time is needed for the first weld although succeeding welds in a repeat series could be made with very short strokes and correspondingly short squeeze times. Type FG timers provide a fifth timing period called "Squeeze Delay" which makes the squeeze times for the first and succeeding welds independently adjustable. The result is a substantial saving in time on repeat welding jobs.



The synchronous motor is geared directly to the cam shaft, thus eliminating the possible difficulties of mechanical or magnetic clutches. The capacitor braking circuit stops the motor quickly and accurately. The motor runs only while the operator is making welds. For complete details, address Square D Company, Industrial Controller Division, 4041 N. Richards St., Milwaukee 12, Wis.

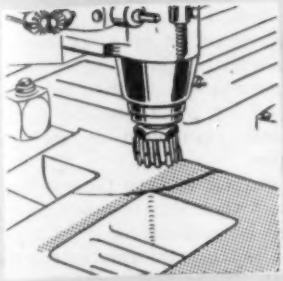
MULTI-TRANSFORMER MULTI-SPOT WELDING OFFERS HIGH PRODUCTION OPPORTUNITIES

With the tremendous development recently in the way of automatic multiple spot-welding machines—Hydromatics, Ultra-Speeds, Progress-O-Matics, Battery-operated machines, etc.—a type used quite a few years ago has also made a new bid for prominence—the "Multi-Transformer" welder.

In this type of machine, small individual transformers are used for each weld or pair of welds. Advantages of this arrangement are that greater variation can be incorporated if desired in the weld characteristics and that the machine may be easily reworked in case of model or design changes, by relocating the guns and their transformers, or adding or removing standardized gun and transformer assemblies as needed.

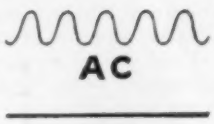
A recent new development in multi-transformer machine is shown in the accompanying illustration. The machine, built by Progressive Welder Co., 3050 E. Outer Drive, is designed to produce some 300 steel drawers per hour, the operation consisting of joining the drawer front to the body of the drawer and adding a stop clip to the bottom of the drawer, as shown in the accompanying sketch. A total of 12 welds is required for each drawer.

The machine has three separate units, performing identical operations on three sizes of drawers. Each unit has six 14 kv. transformers, each transformer taking care of two welds in series, thus permitting ex-



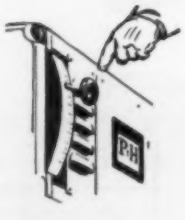
FULLY MACHINABLE welds are yours when you use "Nicast". It gives you weld deposits that match closely the color of cast iron.

IT'S "NICAST" FOR MACHINABLE CAST IRON WELDING



AC OR DC, whichever your machine, you can use "Nicast" for sound, easy welds on cast iron. And "Nicast" is available in the two preferred sizes —1/8" and 5/32" by 14".

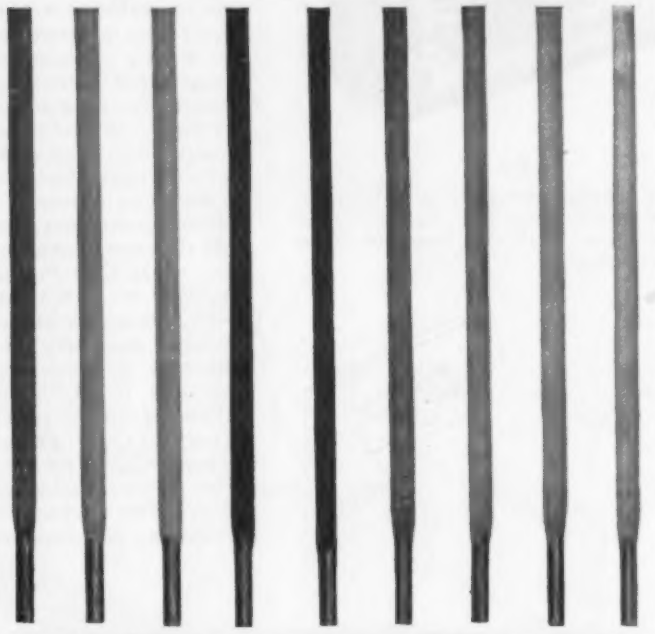
ALL POSITION WELDING. Lay in fast, easy welds in any position with "Nicast" — flat, vertical, overhead or horizontal.



LOW AMPERAGE. "Nicast" was designed for use in the low heat range. It puts an end to the old troubles characteristic of electrodes too "hot."

LESS PREPARATION. Another important feature of "Nicast". Most applications require no time-taking preheating or postheating. Welding is simpler, faster.

CALL ON P&H FOR ALL ELECTRODE REQUIREMENTS

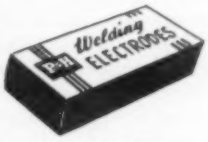


There is a P&H Electrode in the correct type and size for all mild steel applications as well as for welding stainless and alloy steels and for hard surfacing. Above are shown a few of the complete mild steel group.

AMERICA'S MOST COMPLETE ARC WELDING SERVICE

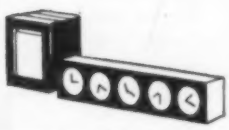
DC WELDERS

AC WELDERS



WELDING ELECTRODES

WELDING POSITIONERS


WELDING PRODUCTION CONTROL SYSTEMS

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HARNISCHFEGER CORPORATION

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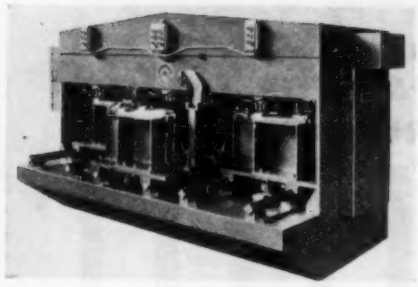


Fig. 1

This automatic Progressive Multi-Transformer welder can turn out 300 steel drawers per hour—100 each of three different sizes.

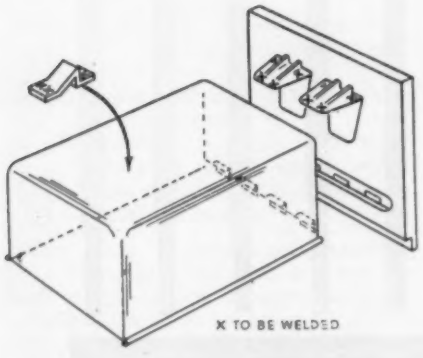


Fig. 2—Showing Parts to Be Assembled and Welds Made

tremely rapid welding. Depending on power available, all guns in one unit can weld simultaneously; or half of the guns can weld simultaneously, followed immediately by the other half; or guns can weld in pairs, one pair after the other.

In operation, the operator loads the drawer parts in place on the fixture and pushes a button. Automatic air clamps hold the parts in place. An air cylinder then automatically rolls the fixture into welding position. All guns come down together under hydraulic welding pressure. Welding current goes on automatically. When welding cycle is completed, guns raise automatically, and the fixture rolls out into loading position. Machine control is through an automatic sequencing panel.

Each of the three welding units is independent of the other two. Use of two operators is not essential except when production is sufficiently high to warrant use of machine to maximum capacity. However, the welder can actually produce drawers faster than a single operator could conveniently keep loading it.

McKAY FROGALLOY ELECTRODES

During the past few years, The McKay Co. has developed and at present is producing the Frogalloy Electrodes which are designed especially to deposit work-hardenable, wear-resistant weld metal. These electrodes fill a variety of applications which require weld metal that will withstand wear under repeated impact with minimum deformation, and without spalling or cracking.

Applications of the Frogalloy Electrodes

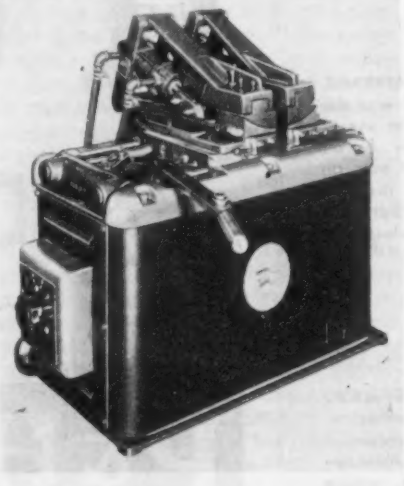
The Frogalloy Electrodes are being used widely in the railroad industry in the build-up and repair of either high-manganese or high-carbon switch points, frogs and crossings. Frogalloy is also used in the maintenance welding of wobblers, spindles and other rolling mill equipment, as well as in the welding of high manganese, high-strength steel plates in the fabrication of products that must stand continual abrasive wear. In all of these applications the Frogalloy weld metal with its drastic work-hardening properties has shown the ability to withstand repeated impact with excellent wear-resistant characteristics.

At the present time there are two versions of McKay Frogalloy Electrodes: Frogalloy M (E-973) and Frogalloy C (G-87). Frogalloy M electrode has been developed essentially for the welding of manganese steel castings which contain from 12.0 to 14.0% manganese. The majority of railroad switch frogs are castings of this type. Frogalloy C electrode has been designed for the welding of high-carbon, heat-treatable castings or machined carbon steel assemblies, as well as high-carbon, high-manganese steel plates.

BENCH-TYPE BUTT WELDER

Announcement is made of a compact new bench-type butt welder by Banner Products Co., 4961 N. 29th St., Milwaukee 9, Wis. The 10-kva. model shown is manufactured for either 220- or 440-volt, 60-cycle current.

Outstanding features are eight ranges of heat, round steel guides for movable platten in oilite bushings, ample grease outlets and convenient built in tap switch. Head is built of high-strength bronze, water cooled, and has good electrical conductivity. Transformer is water cooled with asbestos shield.



Perfect alignment and precision workmanship are assured through use of 2 in. diameter air block on clamping jobs. The blocks maintain a constant pressure on material being welded.

Operation is started by a covered foot switch connected to a 4-way Solenoid air valve which brings clamps to position. Movable platen has left-hand lever with pilot switch connection which closes to apply current at joint, at the same time hand lever is pulled toward stationary platen for upset. Current is automatically shut off by an adjustable limit switch. Air line equipment is included with machine.

Of interest to even the smallest shop is the fact that this compact modern butt welder is available at a nominal initial cost. Further information furnished on request.

ELECTRODE FOR MACHINABLE WELDS ON CAST IRON

Airco No. 375 electrode for machinable welds on cast iron, a recent product of Airco research, has been announced by the Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y.

This is an electrode with a high nickel core wire and a heavy extruded coating that has a possible application wherever an electrode is used on cast iron. It is felt that this electrode will be of special use in the automotive field for production line repair work and for use on all castings requiring machinable welds. Ordinarily preheating is not necessary.

Because of its high nickel content, Airco No. 375 flows exceedingly well and the resultant deposit is sound. The weld and fusion zone is soft and easy to machine. Also, it will withstand hydrostatic pressure and may be used with ease in the downhand, vertical or overhead positions. Multiple pass welds can be made without danger of cracking.

This new electrode may be used on either a. c. or d. c. and is available in $^{5}/_{32}$ in. and $^{1}/_{8}$ in. diameters. The manufacturer plans to add $^{3}/_{32}$ in. and $^{3}/_{16}$ in. diameters if the demand for them is large enough to warrant their addition.

Further information on the new Airco No. 375 electrode is available on request from the manufacturer. Inquries may be directed to the New York office or any Airco district office.

LIGHT GAGE WELDING ELECTRODE

The A. O. Smith Corp. is announcing the manufacture of a new welding electrode, the SW-16, for light gage welding in the sheet metal field.

It is a high-speed, heavy-coated electrode for all position welding on mild steel of light gage. The new electrode welds with a minimum build-up and produces a bead contour that requires little finish grinding. The welding characteristics guard against bead sagging and burning through.

The SW-16 electrode is capable of a wide variety of applications in the automotive industry, as well as in the manufacture of stoves, refrigerators, deep freeze units, air-conditioning equipment, grave vaults, light gage tanks and other types of sheet metal fabrication.

IN RESISTANCE WELDING

why use just one line...

when you can use *three!*

THREE-PHASE

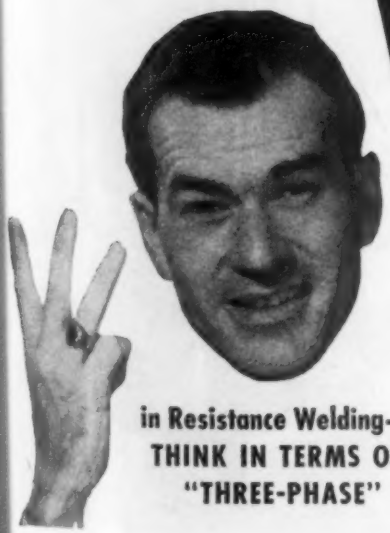
DRAWS BALANCED 3-PHASE LOAD

USES 75% LESS LINE CURRENT

AT NEAR UNITY POWER FACTOR

This Sciaky "Three-Phase" Welder draws a balanced load from all three phases of your supply—requires only 50 amps. to do a 200-amp. job—at better than 80% power factor.

Write Today for Full Details



in Resistance Welding—
THINK IN TERMS OF "THREE-PHASE"

SCIAKY

SCIAKY BROS., Inc.

4925 W. 67th St., Chicago 38, Ill.

NEW TYPE CAST-IRON ELECTRODE

"Nicast" is a new P&H electrode reported by the manufacturer to put cast iron in a class with steel for ease of welding and finishing.

For maximum usefulness, it was made to operate on either a.-c. or d.-c. current. Welds produced by "Nicast" are strong and nonporous and fully machinable in both the weld and fusion zone areas. The unusual machinability of "Nicast" makes it possible to drill, tap, mill or machine weld deposits in any manner, shape or form.

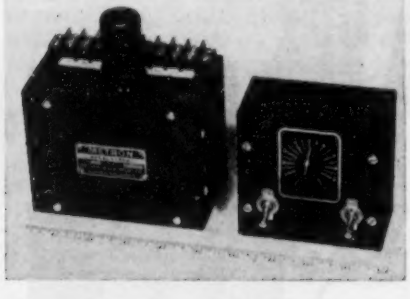
This new P&H Electrode is ideal for repairing broken castings, building up worn castings, correcting machining errors and welding cast iron to steel.

Most applications require no preheating or postheating and welds will withstand hydrostatic pressure. "Nicast" is an all-position electrode and performs well in flat, vertical, overhead or horizontal work.

"Nicast" is now available at P&H distributors in either $^1/_8$ in. or $^5/_{32}$ in. x 14 in. sizes. Further information can be had by writing Harnischfeger Corp., Welding Division, Milwaukee 14, Wis.

SMALL WELDING TIMERS

Welding and industrial timers especially designed for the equipment manufacturer are exceptionally small and permit highly versatile application. The control box which is only 4 x 4 x 2 in. can be mounted with bracket or incorporated in the machine by flush mounting in any panel surface near the operator with the timer box mounted anywhere out of the way; or the control box can be screwed to the timer box for mounting as an integral unit. The timer is of the well-proved electronic type with no mechanical components to wear out. One tube and 2 relays are employed and conservatively used for long life.



Timing intervals from $^1/_{60}$ second up to several minutes can be provided in one or several continuously variable ranges. Adjustability by steps or fixed interval timers are also available. The timing accuracy is high and it is substantially unaffected by wide variations in line voltage or temperature. Neither dependability nor life has been sacrificed to obtain small size and weight. The price of the timer is competitive even in small quantities and substantial savings are realized in large quantities.

Metron Instrument company, 432 Lincoln St., Denver 9, Colo.

NEW ELECTRODE FOR WELDING CAST IRON

A new electrode for welding cast iron where the weld must be machinable has been announced by the Electric Welding Division of the General Electric Co. Designated W-2075, the new electrode is composed of pure nickel core wire and an extruded black covering which is largely consumed in the arc and produces very little slag. The arc stabilizing ingredients used in the covering make this electrode useful a. c. and d. c. (reverse polarity).

The electrode may be used in all welding positions. The nickel deposit eliminates the hard zone found in welds made with mild steel electrodes on cast iron. Although the composition of the deposited metal is different from the cast iron, the color match is close, and welds are not readily detected on machined surfaces. The deposits, though convex, are smooth and uniform, and well bonded to the cast material.

STAINLESS STEEL ELECTRODES

A complete line of stainless steel electrodes in a full range of grades and diameters has been announced by Wilson Welders & Metals Co., Inc., 60 E. 42nd St., New York 17, N. Y.

All Wilson stainless steel electrodes are furnished with a heavy extruded lime type coating for d.-c. application. In addition all but the straight chrome analyses are obtainable with a lime-titania type coating which is usable on a. c. or d. c. The slag produced by either of these coatings is easily removed.

Electrodes with the lime-titania (a.-c.–d.-c.) type coating offer many desirable features not found in the lime type coated electrodes. For example, satisfactory usability on a. c. eliminates arc blow and results in easier manipulation, more uniform arc action and better appearance of deposit. This class of electrodes can be recommended for all applications on which the lime type of electrode is used, with the possible exception of highly restrained joints on heavy sections or on steels of high hardenability.

Further information on the new Wilson line of stainless steel electrodes can be obtained by writing directly to the manufacturer.

THE McKAY HARDALLOY ELECTRODE

One of the newest arc-welding electrodes which The McKay Laboratories have developed is the Hard-Surfacing Electrode. This electrode incorporates some of the newest ideas in electrode technology, and is designed to provide weld metal that will give greatly increased life to parts subjected to impact or abrasive wear.

Applications and Test Data of Hardalloy Weld Metal

The characteristics which this electrode combines in the weld metal make it an outstanding alloy, not only for the protection of new parts to insure greater efficiency, but also as a repair overlay on worn equipment. In the welding of tractor parts, roll crushers, quarry screens and other heavy equipment, the weld metal has sufficient hardness and toughness to resist impact with minimum wear-down of the metal surface. Although the weld metal as deposited has relatively high hardness (Rockwell C-59.0), tests have shown no cracking or spalling of the metal surface under repeated impact.

Many of the hard-surfacing reclamation jobs involve the welding of hardenable steel base metals. One of the greatest hazards in welding these steels is the occurrence of under-bead cracks in the heat-affected zone of the parent metal. The Hardalloy Electrodes have a low hydrogen coating which minimizes under-bead cracking in the welding of these hardenable steels.

C1J GRID CONTROL RECTIFIER TUBE

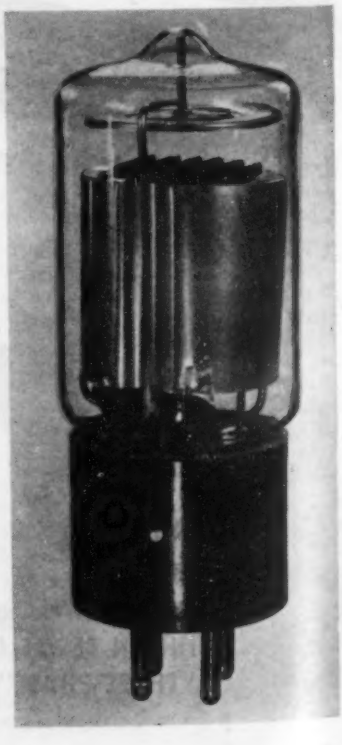
Electrons, Inc., 127 Sussex Ave., Newark 4, N. J., announce a new grid Control, Xenon gas-filled rectifier tube, Type EL C1J.

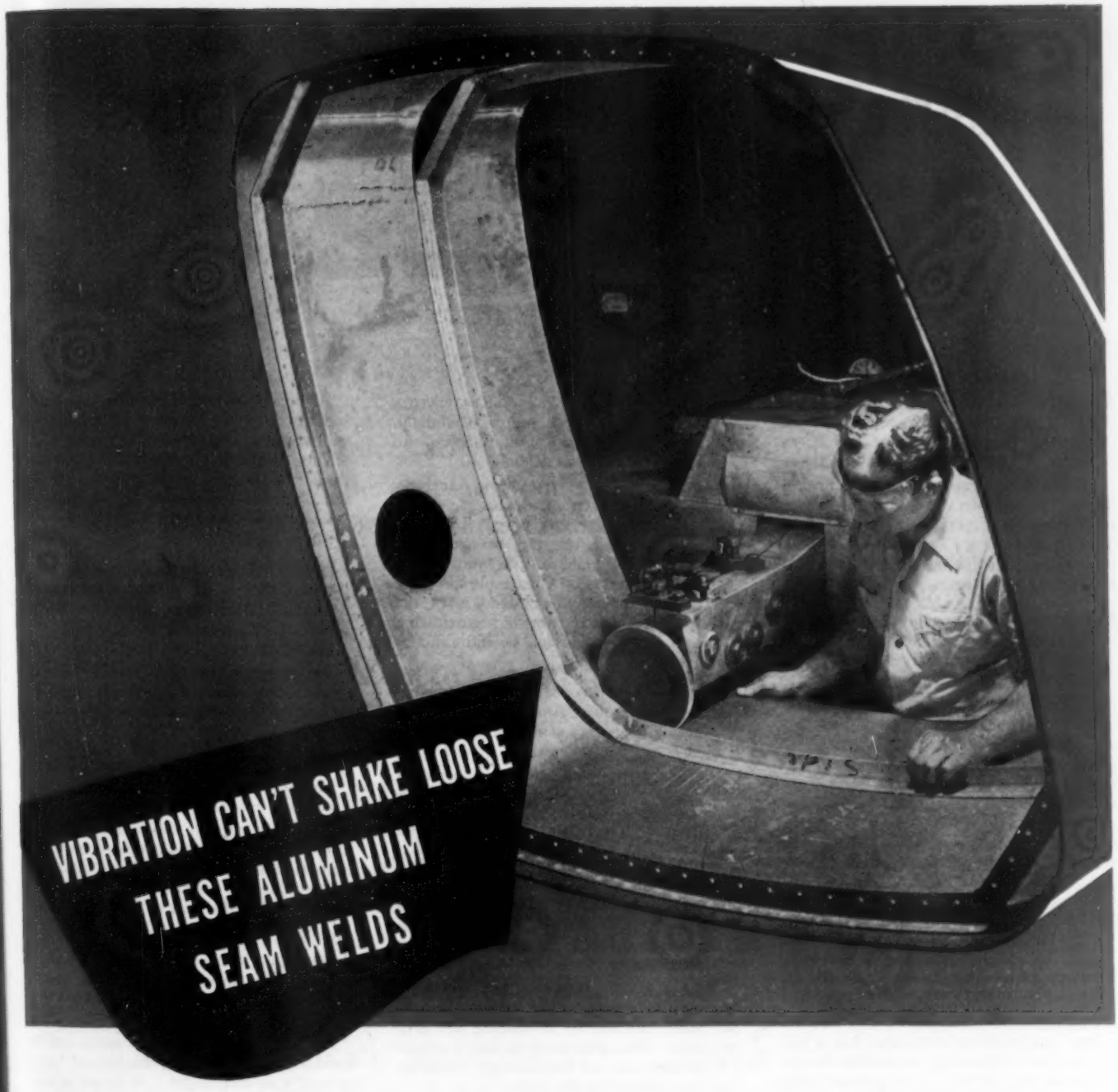
Characteristics

Average anode current—1.0 amp. d. c.
Peak anode current—8.0 amp. d. c.
Maximum peak inverse voltage—700 v.
Average arc drop—8 v.
Filament voltage—2.5 v.
Filament heating time—40 sec.
Over-all length—$4^1/_2$ in.
Temperature free

Applications

EL C1J may be used for precise motor speed control, servo amplifiers, high-speed or synchronous switching circuits, and high-speed counting or inspection circuits. It is ideal for the control of a power circuit from a very feeble or low energy control circuit particularly where either high-speed response or delicate variation of output power is required.





Electric-resistance seam welding joins the extruded aluminum stiffeners to the aluminum body sheets of this marine gasoline tank. Seams are tight and strong, will stay tight under the vibration and twisting of service in high seas.

Write today for your copy of "Welding and Brazing Alcoa Aluminum". It contains 120 pages of technical information and data that will answer most of your questions. And our technical experts will be glad to help you with any unusual welding problems.

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IN EVERY COMMERCIAL FORM

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 25¢ from the Commissioner of Patents, Washington 25, D. C.

2,415,815—METHOD OF THERMOCHEMICALLY CUTTING METAL—George M. Deming, inventor, Orange, N. J., assignor to Air Reduction Co. (5 Claims)

In this process, an oxygen jet is directed against heated metal and the oxygen jet has finely coated metal particles fed into it. The metal particles are adapted to resist combustion until subjected to the heat of the cutting operation.

2,415,912—METHOD AND APPARATUS FOR PRESSURE WELDING METAL MEMBERS—Egon B. Scherl, inventor, Niagara Falls, N. Y., assignor to The Linde Air Products Co. (11 Claims)

Scherl's patent covers both method and apparatus for welding the abutted ends of tubes together and he inserts a combustible alignment member in the bores of the abutted tubes at their contact zone. The abutted metal is heated, upset and then a combustible gas is fed thereto to burn off undesired metal and the alignment member.

2,415,987—APPARATUS FOR BUTT WELDING—Herbert A. Bissout, Merchantville, N. J., and William Y. Borresen, Philadelphia, Pa., inventors and assignors to W. K. Mitchell & Co., Inc. (5 Claims)

This butt-welding apparatus has a pyrometer for controlling an electric heater circuit for the portion of the articles being butt welded. When the pyrometer opens the heating circuit, it closes control means for a hydraulic ram that forces the articles together to form a pressure weld.

2,416,045—WELDED ENGINE FRAME CONSTRUCTION—Everett Chapman, inventor, West Chester, Pa., assignor to American Locomotive Co. (8 Claims)

This patent covers a special engine frame, the units of which are welded together.

2,416,047—COMBINED REACTOR AND INDUCTION PREHEATER FOR USE IN ELECTRODE ARC WELDING—George A. Dolan, inventor, Hasbrouck Heights, N. J. (4 Claims)

Dolan's structure includes a transformer which has a magnetic circuit adapted to be completed through the metal to be heated. The transformer has a low-frequency primary power supply and a short-circuited secondary for close application to the metal to be heated.

2,416,161—HEATING FLAME REGULATION—Eibe W. Deck, inventor, Plainfield, N. J., assignor to Union Carbide and Carbon Corp. (24 Claims)

According to this patent, a relatively high oxygen content oxidizing gas and a relatively low oxygen content oxidizing gas are mixed with the pressure and amount of the high oxygen content gas being controllable. A variable pressure fuel gas is supplied for mixing with the oxidizing gas, and the flow of the oxidizing gas and the fuel gas can be individually throttled.

2,416,204—VENTED MOLDING FERRULE FOR ELECTRIC STUD WELDING—Ted Nelson, inventor, San Leandro, Calif. (3 Claims)

This special ferrule is for use in welding a stud to a plate and includes a sleeve having a bore therethrough with one end of the sleeve being enlarged to receive the stud and provide a welding chamber thereabout.

2,416,278—OXYARC UNDERWATER CUTTING TORCH—Harold Orville Austin and Edward D. Bunnell, inventors, United States Navy. (13 Claims)

This is a fully insulated oxy-arc torch having a grip portion and an oxygen supply valve opened by increasing the grip pressure. The grip portion has a chuck for an electrode and for pressing a terminal contact against the electrode.

2,416,365—FLUID COOLED ELECTRODE—John J. Wisler, inventor, Columbia, Pa., assignor to Armstrong Cork Co. (1 Claim)

Wisler's patent covers a fluid-cooled electrode having an offset tip.

2,416,374—METHOD AND APPARATUS FOR SPOT WELDING—Paul E. Brunberg, inventor, Detroit, Mich., assignor by direct and mesne assignments, of forty-five one hundredths to Nita Carol Brumberg. (3 Claims)

A method of cooling and protecting the electrode and work in spot welding is taught in the above-identified patent. A compressed nonoxidizing gas is permitted to expand partially in the electrode body and expand completely adjacent the tool and work to cool same by the refrigeration effect of the gas.

2,416,379—WELDING METHOD—Willi M. Cohn, inventor, El Cerrito, Calif. (2 Claims)

A special method of welding two metals having different chemical characteristics is disclosed. It comprises welding a metal of intermediate chemical characteristics to each of the base metals and next joining the coated base metals by electric arc deposition of metal on the coated parts of the base metal.

2,416,399—TORCH HOLDER ASSEMBLY FOR GAS CUTTING OR WELDING MACHINES James D. McKierman, inventor, Brooklyn, N. Y., assignor to Air Reduction sales Co., Inc. (13 Claims)

This patent covers a special type of torch holder wherein an electric motor is carried by the torch holder for controlling its position.

2,416,454—WELDING MACHINE—William Morton and Ray M. Murray, Jr., inventors, Seattle, Wash. (9 Claims)

A welding gun is shown and it has a supporting body with a chuck reciprocably supported therein. A solenoid and core are provided to control the chuck in accordance with the flow of welding current.

2,416,690—APPARATUS FOR HANDLING WELDING RODS OR THE LIKE—Wilbert E. Hardy, inventor, McKees Rocks, Pa., assignor to The McKay Co. (4 Claims)

Hardy's patent relates to apparatus for handling magnetic rods discharged longitudinally in free flight. A target is provided to arrest the flight of the rods and a magnet, located adjacent the target, draws the rods onto a conveyor.

2,416,764—WELDER'S HELMET—Harold Roy Madson, inventor, Glen Ellyn, Ill., assignor to Welding Apparatus Co. (12 Claims)

This welder's helmet is mounted on a head harness and it has a chin-operated lever for operating a movable lens pivotally carried on the helmet.

2,416,841—ELECTRODE HOLDER.—Frank J. Nowicke, inventor, Hanover, Md. (2 Claims)

Two substantially identical jaw members are provided and are controlled by a cam having an operating lever associated therewith in this holder.

2,416,863—PREHEATING METHOD FOR WELDING RAILS AND MOLD THEREFOR—Edward F. Begtrup, inventor, Elizabeth, N. J., assignor to Metal & Thermit Corp. (10 Claims)

Three Sources of SAFETY

In the NCG Rego Two-Stage RegOlator there are *three* perfected features to protect the operator, the regulator and the torch in the handling of high pressure gases. Any one of these devices affords normal safety but taken together they make assurance triply sure.

First, the body is an extra-strong heavy forging. Second, the cartridge filter . . . put there to screen out rust, dirt and dust . . . also does a full job of compression-heat absorption and radiation. Finally there is a foolproof valve that automatically relieves any excess of pressure . . . and automatically reseats itself.

These features are provided just so the Rego RegOlator can *start* to do its job properly. Carefully selected materials and precision-made working parts assure long-life, dependable performance with complete safety through that longer life.

Adjustments are made with ease and certainty. The adjustment screw is of large diameter and moves on a thread designed to permit delicate and sensitive settings. Other features contribute to fractional pound accuracy and sensitive adjustment including the lowest ranges.

Once a setting is made, Rego RegOlators maintain pressures without variation. The welding flame will not turn oxidizing or carbonizing on pressure drops. Generously proportioned, correctly profiled gas passages pass large volumes of gas freely, assuring efficient emptying of cylinders.

The same broad-gauge engineering is maintained in Rego Single-Stage Regulators and you are invited to send for bulletin NR-151A which describes both single and two-stage regulators.

NCG

EVERYTHING FOR WELDING

NATIONAL CYLINDER GAS COMPANY · 205 W. WACKER DRIVE · CHICAGO 6, ILL.

Begtrup's patent discloses a mold for use in the aluminothermic welding of metal parts, one of which has a portion of larger cross section than another portion. The mold forms a mold cavity enclosing the metal parts and it has a preheating gate connected with the mold cavity and having preheating vents connecting to the metal portion of larger cross section to preheat the metal parts equally.

2,416,872—Welding Tool—Joseph U. Garibay, inventor, Montebello, Calif. (1 Claim)

In this patent, jaw extension means for a welding tool are disclosed and they are adapted to engage with various sizes of electrodes.

2,416,915—Single Leg Support for Welding Guns—Charles S. Evans, inventor, Atherton, Calif., assignor to Ted Nelson. (9 Claims)

Evans' structure is for use in welding a stud within a ferrule, and a ferrule chuck is mounted on a welding gun and positioned on one side of the stud chuck.

2,416,954—Stud Welding Gun—Herbert S. Remmer, inventor, Oakland, Calif., assignor to Ted Nelson. (6 Claims)

This structure relates to that of patent 2,416,915 and has a sleeve surrounding and axially adjustable of the stud chuck. A dielectric bushing is between the sleeve and stud chuck.

2,417,075—Welding Apparatus—Kenneth V. Hart, inventor, Cleveland, Ohio (16 Claims)

Hart's apparatus comprises a pressure head which has an inner head mounted on a tube which is slidably mounted in the pressure head. Spring means press against the inner head.

2,417,412—Apparatus for Cutting Tubes—Harry T. Herbst, inventor, Baltimore, Md., assignor to Union Carbide & Carbon Corp. (8 Claims)

This patent covers special apparatus for mounting a cutting nozzle to project an oxygen stream substantially parallel to a tangent to a tube to be cut and perpendicular to the longitudinal axis of the tube.

2,417,511—Torch Cutting Machine—Chester Mott, Evanston, Ill., and Alfred F. Chouinard and John F. Dove, Chicago, Ill., inventors and assignors to National Cylinder Gas Co. (16 Claims)

Special mounting rails for positioning a carriage having a cutting torch thereon are disclosed in the patent.

2,417,547—Electrode Holder—Thomas S. Donnelly, inventor, Detroit, Mich. (5 Claims)

The jaw of Donnelly's holder has an elongated gripping member and lateral wings projecting outwardly from the member intermediate its ends.

2,417,650—Cutting Torch—Charles Kendel, inventor, Jackson Heights, N. Y. (28 Claims)

In this patent, an electric cutting head having an electrode mounting metal head is disclosed. The head has a gas and an electric conduit connected thereto with a gas control valve being associated with and insulated from the head.

2,417,662—Method of Brazing Aluminum—Joseph G. Rosales, inventor, Los Angeles, Calif., assignor to The Garrett Corp. (7 Claims)

Rosales' method relates to brazing a core assembly having aluminum tubes with enlarged ends wherein the tubes are heated, the ends of the tubes are dipped in molten flux and next in molten filler metal, then turned end for end and the dipping cycle again performed.

List of New Members

March 1 to March 31, 1947

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Ferguson, Harry J. (B), 95 Brook Rd., Milton, Mass.
Gasparri, Armando U. (B), 32 Vernon St., Malden, Mass.
Pomfret, Richard A. (B), Bethlehem Steel Co., 97 E. Howard St., Quincy 69, Mass.

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Ruzek, Ing J. (B), Praha V11, Ovenecka 7, Czechoslovakia.
Schepers, Pierre (B), 4 Place D'Italie, Liege, Belgium.
Simpkins, Thomas W. (B), P. O. Box 1676, El Paso, Tex.

Members Reclassified

During Month of March

BIRMINGHAM

Curry, Don H. (C to B), 1420 N. 32nd St., Birmingham 4, Ala.

INLAND EMPIRE

LaVelle, Eugene B. (C to B), Rt. 1, Box 430, Coeur D'Alene, Idaho.

NEW JERSEY

Butler, Laurence B. (C to B), 551 Morris Ave., Elizabeth, N. J.

SECTION ACTIVITIES

CLEVELAND

The Cleveland Section, at its regular monthly meeting on April 9th, had as speaker A. T. Waidelich, Assistant Director, Research Division, The Austin Co. The subject of Mr. Waidelich's talk was "The Austin H-Section Welded Truss." The H-Section welded truss, which was developed in the Research Division of The Austin Co., has had widespread use, and is of particular interest to welding engineers, since it was developed specifically for welded fabrication. The development included a number of interesting and unusual tests which were illustrated by slides. A motion picture showing fabrication and development scenes was also shown and was received with considerable interest.

The coffee program was a recognition of past officers of the Cleveland Section and a presentation of Society pins for service.

COLORADO

Election of officers for the Colorado Section was held at the Oxford Hotel, Denver, on Wednesday evening, March 12th and resulted in the following being elected to the respective offices: Chairman, H. Jackson; Vice-Chairman, J. A. Hynds; Secretary-Treasurer, C. Brinton Swift; Executive Committee—Edmund J. Berens, Maurice Eddy, Howard K. Schmuck; Membership Committee, Howard K. Schmuck.

After-dinner speaker at this meeting was L. E. Bruce, who gave a very entertaining talk on Big Game Hunting and Fishing in Alaska.

Merrill S. Rosengren, Engineer, Stearns Roger Mfg. Co., Denver, spoke at the technical meeting on "Flame Hardening as Applied by Modern Machines." Mr. Rosengren's talk was illustrated with slides and film. The matter of flame hardening has been accomplished in the past with machines made up for the job. This talk covered the new machine Stearns Roger are building which will mechanize all flame hardening. Considerable interest was shown by all.

COLUMBUS

At the regular meeting held on Friday, March 14th, the dinner speaker was Fred Posey of the Columbus *Dispatch*. Mr. Posey is featuring an article on welding in his column in the Columbus *Dispatch*, a daily paper. He has visited several plants in Columbus and, taking the information he has received through various sources in and around central Ohio, is writing his material therefrom.

At the technical session R. David Thomas, Jr., Vice-President and Director of Research and Engineering, Arcos Corp., spoke on "Arc Welding and Arc-Oxygen Cutting of Stainless Steels." This was a very interesting and instructive meeting as this was the first time information on this subject has been presented to the members of the Columbus Section. Mr. Thomas explained the various uses of this method through slides and movies.

DAYTON

Mr. Charles H. Jennings, Engineering Manager of the Welding Department of Westinghouse Electric Corp., was the guest speaker at the March 26th meeting held at The Engineers' Club. Mr. Jennings discussed "Welding Design" and covered the practical phases of design with particular reference to production problems.

DETROIT

Annual Welding Conference and Ladies Night will be held in May.

HARTFORD

A joint meeting of the Bridgeport, Springfield and Hartford Sections was held on Thursday, March 20th. A plant inspection of the welding operations at the Whitlock Manufacturing Company, Elmwood, Conn., took place at 3:00 P.M. Dinner at 6:30 P.M. at the University Club. At 8:00 P.M. there was an address by Dr. Wendell F. Hess on the subject "New Frontiers in Welding." Dr. Hess is Past-President of the Society and Head of the Welding Laboratory at Rensselaer Polytechnic Institute, Troy,

Weltronic Announcing

A NEW SERIES

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WELD TIMER-CONTACTORS

New electronic circuits reduce moving parts to one NEMA 00 type relay for energizing solenoid valve on welder.

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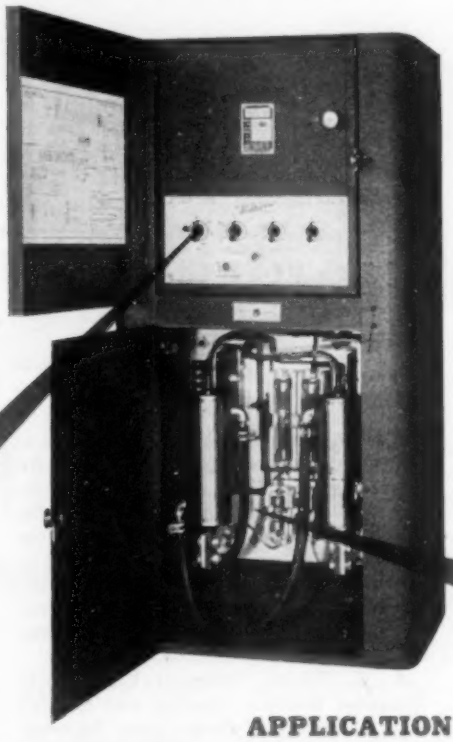
FIRING RELAY ELIMINATED

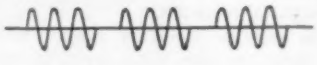
Thyratron tubes fire ignitrons direct

GONE

SEQUENCING RELAYS ELIMINATED

Replaced by tube sequencing





The start of every new weld is opposite in polarity to the finish of the last weld, thus preventing transformers from "building up" and saturating.

NO RECTIFIERS REQUIRED

Direct thyratron tube firing of ignitron contactor eliminates necessity of rectifiers. Same as on previous synchronous controls

MORE ACCURACY

Due to inherent characteristics of tube sequencing and tube ignitron firing far greater timing accuracy is obtained.

MORE WELDS PER MINUTE

Because sequencing and ignitron firing is fully electronic much of the mechanical element tending to slow up the welding cycle is eliminated. Timers can operate up to 500 welds per minute.

APPLICATION

Weltronic timer-contactors provide simple, low-cost means of accurate automatic electronic control of electrode movement and pressure, as well as duration of weld current. Use of timer-contactor relieves the operator of the timing and operating and virtually eliminates all burned welds. Models are available for foot operated spot, projection, and butt welders, including cam-timed machines.

These controls are complete "package" combination units, completely wired and ready to install. A universal wall or floor mounting cabinet houses either a NEMA 1A, 3B, or 5B timer and Ignitron Contactor.

WELTRONIC COMPANY

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N. Y. He is a noted lecturer, the author of numerous papers and articles on welding, and is rated as one of the country's leading authorities on this subject.

Following Dr. Hess' address, a 16 mm. sound movie made by the Canadian Liquid Air Co. was shown. It is called "No Keener Blade," and clearly illustrates how oxyacetylene cutting machines were used in Canada during the war to produce enormous quantities of war material.

The May meeting will be held on the 15th. Mario Sciaky of Sciaky Bros., Chicago, will speak on "Three Phase Resistance Welding Machines."

INDIANA

The Indiana Section held their March meeting in Anderson on Friday, March 28th. E. A. Mallett, Sales Engineer, of Taylor-Winfield gave a very interesting and instructive talk on "Resistance Welding in Europe." His discussion of tapers as they affected the maintenance on resistance welding electrodes was of special interest to the 115 people present.

KANSAS CITY

The March 13th meeting was held in the Kansas City Power and Light Building. Dinner at Fred Harvey's preceded the meeting. A program of questions and answers on new developments in welding and cutting was presented by J. E. Data, H. A. Yost, P. D. Wade, R. D. Faulkner and T. Anderson.

LEHIGH VALLEY

The regular monthly meeting was held on Monday, April 7th, at the Hotel Bethlehem, Bethlehem, Pa.

The after-dinner program consisted of a talk and demonstration on "Plug Casting" by Billy Sheridan of Lehigh University. Mr. Sheridan's exhibition of plug casting was typical of his skill with the casting rod. His presentation proved to be very interesting and timely.

H. W. Pierce of the New York Shipbuilding Corporation was the guest speaker. Mr. Pierce's subject, "Structural Welding," discussed the failures of welded ships and the research work and investigation which followed. He told of the behavior of wide plates, and of certain properties in plating, bearing on notch sensitivity. Mr. Pierce has had experience in all types of welding and he, therefore, was in a position to speak thoroughly on the subject. His talk was exceptionally well received. An informal discussion between Mr. Pierce and the audience followed.

LONG BEACH

O. D. Lamm of the Haynes Stellite Co. was the guest speaker at the February 21st meeting held at the New Masonic Temple. Mr. Lamm spoke on "Welding of Wear and Corrosion Resisting Alloys."

LOUISVILLE

The regular monthly dinner meeting of the Louisville Section for March was held on the 25th at the Kentucky Hotel. Coffee speaker was Dr. Robert M. Reed, Chief Chemical Engineer, Gas Process Division, Girdler Corp. His subject was "Chemical Industries in the Louisville Area."

Guest speaker was J. A. Gallaher of the Haynes Stellite Co., Chicago. Mr. Gallaher's subject was "Hard Facing." He has had considerable experience in this field and proved to be an interesting and instructive speaker. Mr. Gallaher had numerous slides to illustrate his lecture.

At the April meeting, Leslie S. McPhee of the Whiting Corp., discussed a subject matter which was of definite concern to all. "Bringing the Designer and Welder Together" will do much toward simplifying fabrication of welded products, correction of mistakes and economic benefits which could be far reaching for both job shops and fabricators. Design plays an important part in welding and proper recognition of this fact will further the art greatly.

The May meeting will be a welding conference held jointly with the University of Louisville. Arrangements are under way to make this conference bigger and better in every manner than last year's highly successful event.

MAHONING VALLEY

The March 24th dinner meeting and plant visitation held at the Warner Hotel, Warren, Ohio, had an attendance of 63 at dinner and approximately 125 at the meeting. E. A. Mallett gave a coffee talk on "Traveling in Europe, Post War Style."

The plant visitation was made through the Taylor-Winfield Corp. A new flash strip welder was demonstrated and described in detail by the Taylor-Winfield engineers.

MARYLAND

The March meeting of the Maryland Section was held on the 21st at the Baltimore Engineers Club. Twenty-one members and guests attended dinner at the Club and sixty were present at the meeting.

The entertainment period featured the U. S. Navy motion picture film "Operation Crossroads," depicting the Atom bomb tests on Bikini Atoll.

A. G. Bissell, Principal Engineer in charge of Welding, Casting and Forging Section, Bureau of Ships, gave the evening's technical talk, entitled "Standard Codes for Arc and Gas Welding in Building Construction." Mr. Bissell has been active in welding for over thirty years and was the 1942 recipient of the Lincoln Gold Medal. His talk was both timely and interesting and stirred considerable audience participation at the close of the address.

MICHIANA

G. O. Hoglund, Head of Welding Process Development of the Job Shop, Aluminum Company of America, New Kensington, Pa., was the speaker at the March 21st meeting held at the Bendix Legion Post. His subject was "Welding Aluminum Alloys." He went into the metallurgy of aluminum alloys and described the types of welding, including brazing, available and the alloys to which each was applicable. Following Mr. Hoglund's talk, a series of movies on welding and brazing aluminum were presented. These depicted the technique to be used with the different methods of joining, especially on sheet.

MILWAUKEE

Regular dinner meeting was held on Friday, March 28th at the Ambassador Hotel. After dinner program consisted of a sound color film, entitled "Radio Frequency Heating." This was the first showing of this very recently completed film in this part of the country.

The main speaker of the evening was John J. Vreeland, Metallurgical Engineer, Chase Brass & Copper Co., Waterbury, Conn. "The Welding of Copper and Copper Alloys" was Mr. Vreeland's subject. Mr. Vreeland is author of several papers on the welding of silicon, bronze, copper, red brass, etc. Mr. Vreeland's talk was most educational and beneficial to all present.

The Annual May Party will be held on the 24th.

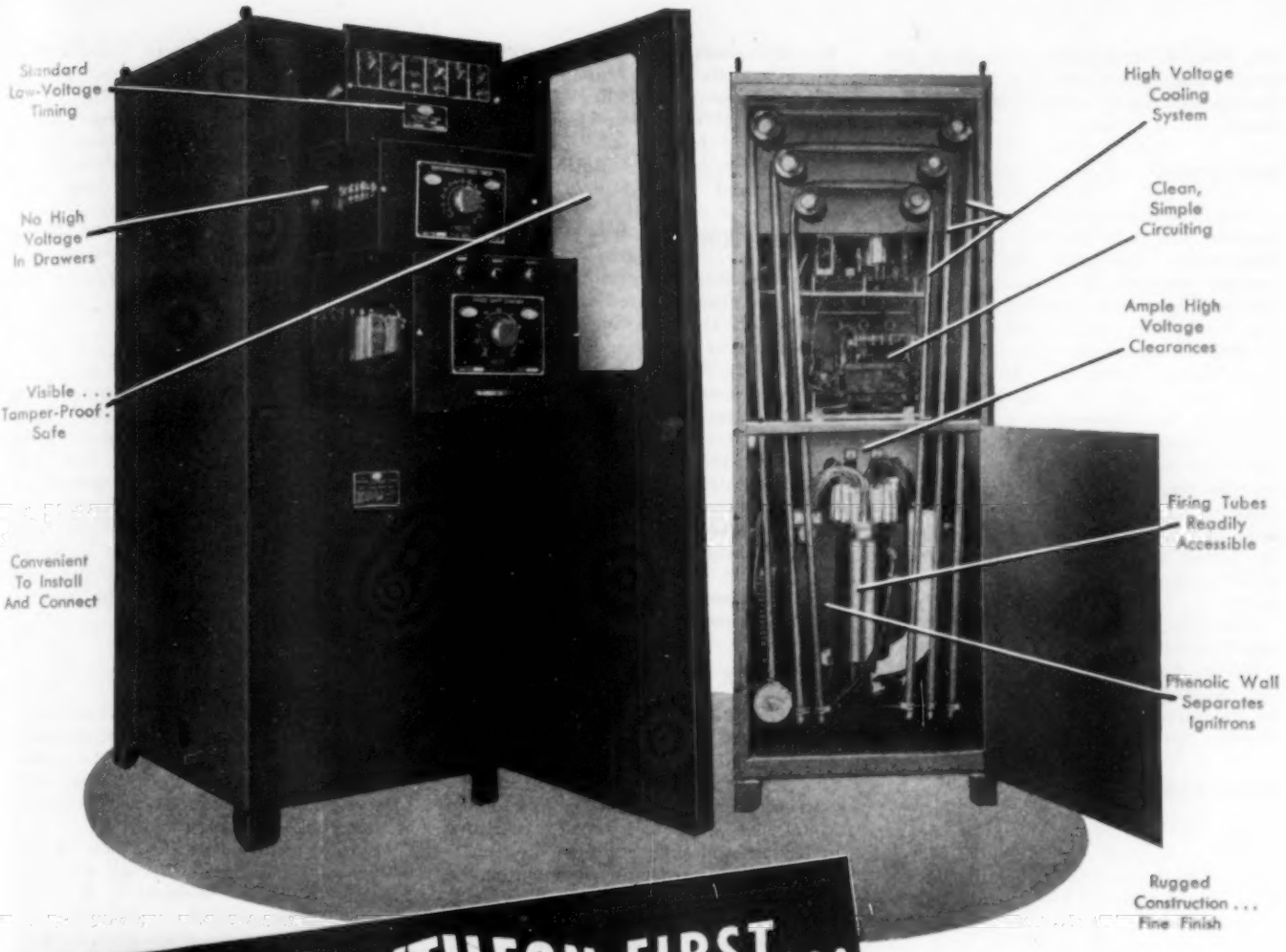
NEW JERSEY

The Executive Committee of the New Jersey Section held a meeting on Tuesday, March 18th, at 5:30 P.M. Among the matters discussed was the outdoor picnic. It was decided that the month of June was too early for the picnic and it was therefore postponed until the month of September, sometime prior to the first regular meeting of the 1947–48 season. In lieu of this action, a motion was made to eliminate the social activities usually connected with the Annual May Meeting and schedule the Annual Meeting activities as well as a Technical Session, the night of May 20th.

The regular monthly dinner meeting was held on the same evening at the Essex House, Newark. The technical paper on "Resistance Welding, Present Status and Future Possibilities," was presented by T. J. Crawford, Consulting Engineer representing the Resistance Welder Manufacturers Association. Due to his wide experience Mr. Crawford was well qualified to present an outline of the resistance welding field of today and tomorrow.

A Magnaflux and Zyglor Inspection Forum was held on Monday, April 7th, in the Public Service Auditorium. The leader of the Forum was Hamilton Migel, of the Magnaflux Corp., New York City. Product improvement, safety, weight reduction by increased working stress, quality control and other important manufacturing factors are related to inspection methods. The magnetic particle and the fluorescent penetrant methods of inspection are being specified more frequently. Their application and limitations were discussed.

The regular monthly dinner meeting for April was held on the 15th at the Essex House. Informal talk and discussion on the subject "Problems of Atomic Energy Application" was led by Albert L. Baker, Vice-President, The Kellex Corp., and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Synchronous Control in Removable Drawer design

First to adapt filing cabinet design to low-voltage Synchronous Control, Raytheon now announces a new *high voltage* unit in a similar type of cabinet. Designed for 2300-volt welding machines, or where series capacitor voltage exceeds 600, Raytheon's new High Voltage Synchronous Control offers many new and outstanding features of design. Write for detailed information.

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Dr. John R. Dunning, Director of Research, Columbia University. An Atomic Energy Commission release film was also shown.

NEW YORK

The March meeting of the New York Section was held on the 12th in the Engineering Societies Building. The speaker was G. J. Gibson, Assistant Research Engineer, Air Reduction Sales Co., Jersey City, N. J. His subject was "Fundamentals of the Inert Gas-Shielded Arc-Welding Process." Mr. Gibson's talk dealt with the experiments his company had performed to determine the optimum operating conditions required for actual production. The paper reported on studies relating to arc length, shielding gases, and other factors in the inert gas-shielded arc-welding process. He traced the history and development of the process and described its present status.

Following the talk, a number of persons asked questions about their particular problems in connection with the use of the process. The Technical Chairman for the meeting was E. Vom Steeg, Jr., Welding Specialist, General Electric Co.

NORTHWEST

The regular monthly meeting of the Northwest Section was held on March 19th at the Covered Wagon, Minneapolis. Paul W. Bowman, Mechanical Superintendent, Seeger Refrigerator Co., St. Paul, spoke on "Welding in Assembly Line Production of Refrigerators." Mr. Bowman covered spot, gas and electric arc welding, and illustrated his talk with slides which were especially made up for this meeting. The Seeger Refrigerator Co. and Mr. Bowman have had considerable experience in this type of production, and his discussion was of interest to all.

PEORIA

The March meeting was held on the 19th at the Jefferson Hotel. Forty-two members and guests attended the dinner. Fifty attended the meeting, which was addressed by Alfred Lautozes, Westinghouse Electric Corp., Chicago. Mr. Lautozes spoke on the subject "Joining of Metals." The presentation covered the methods used in analyzing welding problems to determine the most economical and practical process to use.

PHILADELPHIA

March meeting held on the 17th at the Engineers' Club was addressed by Prof. C. D. Jensen of Lehigh University. Professor Jensen spoke on "Arc-Oxygen Cutting and Underwater Welding."

PITTSBURGH

The March 19th meeting was held at the Mellon Institute of Industrial Research. Dinner at the Hotel Webster Hall preceded the meeting. Twenty-nine members and guests were at dinner while ninety-three attended the meeting. L. K. Stringham, Lincoln Electric Co., Cleveland, spoke on "Imagination—The Key to Automatic Welding." Sound and color films, "Operations Cross Roads," were shown before and "Bikini" after the regular meeting. Both were very well received.

PUGET SOUND

Two outstanding personalities in the welding industry shared the program of the March 19th meeting of the Puget Sound Section held at the Engineers' Club, Seattle. C. P. Croco, Manager of the Welding Department of the Westinghouse Electric Corp., Pittsburgh, spoke on the subject "Developments in A.-C. Welders and A.-C. Electrodes."

L. M. Dalcher, Technical Secretary of the AMERICAN WELDING SOCIETY, was the other speaker at the meeting. Mr. Dalcher's subject "Technical Services Available to the Membership from National Headquarters," was both informative and instructive.

ROCHESTER

The April 3rd meeting of the Rochester Section was held at the University of Rochester. Dinner at the Century Sweet Shoppe preceded the meeting. F. E. Garriott, Development Manager, Ampco Metal, Inc., has had broad experience in ferrous and nonferrous welding engineering and electrode development, spoke on the subject "Welding of Copper and Copper Base Alloys."

A new 16-mm. industrial film in color with narrative and sound depicting the history and development of copper-base alloys was shown. The title of the film is "Golden Horizons."

SAN FRANCISCO

The twenty-fifth anniversary of the San Francisco Section was celebrated with an Official Convention Luncheon and Meeting on Monday, March 24th, at the Zerikotes Lake Merritt Dining Room, Oakland. Master of Ceremonies was C. S. Smith of The Linde Air Products Co. Welcoming remarks were made by Carl J. Eastman, President, San Francisco Chamber of Commerce and James H. L'Hommidieu, President, Oakland Chamber of Commerce. "The Future of Welding in the West" was presented by Lee W. Delhi, President of the A.W.S. Presentation of the Lincoln Gold Medal Award to H. E. Kennedy was made by President Delhi.

The Western Metals Congress was held at the Oakland Auditorium Ballroom, Oakland, Calif., during the week of March 24th. Three consecutive sessions were held on Monday and Tuesday mornings. Two consecutive sessions were held on the mornings and afternoons the remainder of the week. Among the speakers were H. W. Sharp, Sales Metallurgist, Stoody Co.; T. R. Lichtenwalter, Field Metallurgist, Republic Steel Corp., E. R. Proctor, Development Engineer, Menasco Mfg. Co., M. S. Clark, President, Federal Machine and Welder Co.; J. H. Cooper, Chief Sales Engineer, Taylor-Winfield Corp.; G. W. Garmon, Control Division Engineer, General Electric Co.; T. E. Piper, Chief Process Engineer, Northrup Aircraft, Inc.; Fred Boericke, Sales Engineer, Haynes Stellite Co.; J. B. Tinnon, Vice-President, Metal & Thermit Corp.; Earl Griffith, Plant Superintendent, Wooldridge Mfg. Co., C. P. Croco, Manager, Welding Dept. Westinghouse Electric Corp.; LaMotte Grover, Welding Engineer, Air Reduction Sales Co.; Herman Folger, Handy and Harman.

SOUTH TEXAS

James F. Lincoln, President of The Lincoln Electric Co., Cleveland, Ohio, addressed the March meeting of the South Texas Section on Thursday night the 20th, and discussed future prospects of the welding industry. Mr. Lincoln expressed the opinion that welding has only begun its "ascension on the curve of usefulness," Mr. Lincoln pictured a very optimistic future for welding applications.

SYRACUSE

The Syracuse Section held its March meeting on the 12th at the Hotel Syracuse. Dinner was attended by fourteen members and the guest speaker. Eighty-two members and guests attended the meeting. Driving conditions affected the attendance as the roads were very bad.

Speaker at the meeting was R. F. Wyer of the General Electric Co., who spoke on "A.-C. Welding." A sound film, "The Story of A.-C. Welding" was shown through the courtesy of the General Electric Co.

Annual Meeting will be held on May 21st in the East Room, Hotel Syracuse.

TOLEDO

The January meeting of the Toledo Section was held on the 14th in the Toledo Room of the Commodore Perry Hotel. Speaker of the evening was R. H. Davies, Consulting Engineer of The Lincoln Electric Co. His subject "The Design of Welded Steel Machinery," was very thoroughly covered. He traced the development of welding and its phases on the West Coast, in the Midwest and in the East. He stressed the importance of rigidity, tensile strength and elasticity in selection of proper material with which to work. He then presented two excellent color sound motion pictures. The first, entitled "Machine Design," stressed the importance of using the right amount of the right material in the right place. The second picture presented the three cardinal lines for control of distortion, i.e., reduce shrink forces, make shrink forces work for you and balance shrink against other forces.

The March 11th meeting was held in the English Room of the Commodore Perry Hotel. Speaker of the evening was H. O. T. Ridlon, Welding Engineer for the National Cylinder Gas Co., Chicago. His subject, "Gas Welding and Cutting and Safety Practices," was extremely well covered by an acknowledged old hand in the industry. He discussed at length the safety measures that should be considered in the handling, attaching and

using of gas welding and cutting equipment. He covered thoroughly the accepted safe practices in handling oxygen and acetylene cylinders, manifolds and acetylene generators. Since Mr. Ridlon's subject was of such importance to those present an extended question period followed the main talk, highlighted by humorous details of some of the speaker's wide and varied experiences in the industry and in the Armed Services.

WASHINGTON

The regular March meeting was held on the 25th with C. Weston Steward, Cornell Aeronautical Laboratory, Cornell Research Foundation, speaking on "Multi-Arc and Resistance Welding of Aluminum Alloys."

In discussing resistance welding, Mr. Steward restricted himself to several points not frequently encountered and created quite a bit of discussion with his figures on almost unbelievable electrode tip life, joint efficiencies, etc. He then discussed the multi-arc method of welding, of which he is the inventor, and followed this with a film showing the multi-arc in action.

WESTERN MASSACHUSETTS

At a meeting held on February 25th the following officers and directors of the Western Massachusetts Section were elected: Chairman, Sidney Low, Research Engineer, The Chapman Valve Mfg. Co.; Vice-Chairman, Thomas Dyer, Manager, Dyer's Welding and Engg. Service; Secretary, Albert Labossiere, Welding Foreman, The Chapman Valve Mfg. Co.; Treasurer, Howard Walsh, Time Study, Worthington Pump and Machinery Corp.; Directors—Emile Stolte, Frank Taft, Joseph Tinsman, Gordon Clark, Rodolphe Gamache, James Flaherty; Program Committee—Thomas P. Dyer, Emile Stolte, James Flaherty; Membership Committee—Gordon Clark, Frank Taft, LeRoy Pearsall.

WESTERN MICHIGAN

An inspection tour through the Rapids-Standard Co., Inc., Grand Rapids, Mich., was held on Monday Evening, February 24th. This company uses various types of welding in the manufacture of gravity conveyors, power-belt conveyors, trucks and casters. They have the only automatic installation of flame hardening process in Western Michigan.

Dinner at the Association of Commerce Cafeteria preceded the inspection tour.

The March dinner meeting at the Association of Commerce Cafeteria was held on the 31st. A. F. Chouinard, Manager, Research and Development Dept., National Cylinder Gas Co., Chicago, spoke on the subject "Flame Shape Cutting Processes." Mr. Chouinard's talk covered the basic types of shape cutting machines and tracing devices, methods of nesting shapes for economy of plate stock and methods of template storage and work table design. A large number of slides were shown illustrating the various features such as mechanisms permitting cutting in divergent directions simultaneously, and methods to be employed in cutting beveled circular plates on stationary shape cutting machines.

WESTERN NEW YORK

The February meeting of the Western New York Section was held on the 27th in the Hotel Touraine, Buffalo, N. Y. A. M. Setapen, of Handy and Harman, New York, was the speaker. Mr. Setapen is Manager of the Engineering Division of Handy and Harman and has had much to do with the development of low-temperature silver brazing alloys. The subject of the talk was "Low Temperature Silver Brazing." The uses of these alloys were discussed with particular emphasis being placed on the necessity for proper preparation of the material to be brazed. The talk was illustrated with slides. A lively discussion period followed.

The March meeting was held on the 27th at the Hotel Touraine, Buffalo. Forty-three members and guests attended the dinner. Sixty attended the meeting. A movie, "Projection, Spot and Resistance Welding," was shown through the courtesy of the General Electric Co. and was very well received. The technical meeting was addressed by T. R. Lichtenwalter of the Republic Steel Corp., Massillon, Ohio, who spoke on "Welding and Finishing of Enduro Stainless and Heat Resisting Steels." Mr. Lichtenwalter is a very well versed metallurgist and gave a very good talk on a subject that is timely today—stainless steel. A great many questions were asked, questions that operators and engineers are running into every day.

WORCESTER

March 4th meeting of the Worcester Section was held at Howard Johnson's Restaurant. Seventy members and guests attended the dinner and meeting. Richard S. Tobin, President, Power Piping Corp., Cambridge, Mass., spoke on "Pipe Welding." Mr. Tobin has supervised the installation of high pressure pipe lines and boilers in many of the largest power companies and industrial plants in the country and his knowledge and experience in this field proved of great value and interest to his listeners.

CANADIAN

The Montreal Chapter of the Canadian Welding Society held its sixth meeting of the Season on Monday, March 17th, in The Engineering Building, McGill University, Montreal. H. S. Swan, General Welding Supervisor, American Locomotive Co., Schenectady, N. Y., spoke on "General Locomotive Maintenance Welding."

The Toronto Chapter held its April meeting on the 7th at Malloneys Art Gallery. "Welding Metallurgy" was presented by H. J. Nichols, Metallurgist, Bureau of Mines, Ottawa.

The Hamilton Chapter held its April meeting on the 8th at McMaster University, Hamilton. "Welding and Its Application" was presented by Gordon Cape, Welding Engineer, Dominion Bridge Co. Ltd., Lachine, Que.

Employment Service Bulletin

POSITION VACANT

V-206. Resistance Welding Foreman. Must know jigs, fixtures, modern equipment and production methods. Must be able to handle people well. Permanent position with well established Chicago manufacturer.

SERVICES AVAILABLE

A-544. Fourteen years experience in the development and manufacture of all type electrodes and export sale of electrodes. Ability to weld. Seeking permanent position.

A-545. Welding Engineer. Resistance Welding and Brazing. Research, design, development and production methods of jewelry, electronic tubes and instruments. Knowledge of induction brazing and heat treating; metallurgy of welds.

CORRECTION IN LISTING OF CHAMPION GRAY DEVIL NO. 2

In the January advertisement of The Champion Rivet Co., Gray Devil No. 2 electrode was listed as a 6013 rod. This was an error as the rod is, in reality, 6012. The Graydac is the Champion 6013 rod.

SPECIAL BOUND VOLUMES

The AMERICAN WELDING SOCIETY still has left a few bound volumes of THE WELDING JOURNAL for certain years indicated below. In order to dispose of these the Society is offering them at a special reduced rate of $5.00 per volume. They are bound in attractive imitation black leather covers and contain a Subject and Authors Index. The volumes available cover the years 1930, 1931, 1933, 1934, and 1938.

They won't last long, so please get in your order promptly. American Welding Society, 33 West 39th St., New York 18, N. Y.

A CANADIAN WELDING BUREAU*

A new division of the Canadian Standards Association has recently come into operation on the formation of the Canadian Welding Bureau. The Canadian Standards Association undertook this work on the urgent request of a wide section of the welding and fabricating industry.

One of its principal functions will be to ensure good welding by approving shops, engineering and supervisory personnel and operators. The basis of qualification will be the welding codes and specifications prepared by the Canadian Standards Association, which association will progressively prepare and issue codes covering the whole welding field, thus avoiding a costly multiplicity of standards and specifications such as has already developed in some countries.

Approved Fabricators

The Bureau has recognized that the existence of codes is not in itself sufficient to ensure good welding, although they do form a valuable guide. For this reason they do form a valuable guide. For this reason and to satisfy all users and potential users of welding, approval by the Bureau is granted only to those fabricators whose welding equipment, operators, supervisory and engineering personnel satisfy the standards under which the Bureau operates.

Lists of such approved members are now in the course of preparation for release to municipal and city engineers, government departments, architects, consulting engineers, buyers and other interested parties.

The Bureau's engineering personnel is at present busily engaged in testing and according approval under arc welding standards. Codes are projected for resistance welding, gas welding and brazing.

The Bureau is being staffed by experienced welding engineers who, it is anticipated, can be of material assistance to member firms. It will be their duty to assist any firm desirous of becoming a member to meet the standards required and further to generally promote welding and its proper development and progress throughout the Dominion.

Personnel

The newly appointed General Manager of the Bureau is Mr. R. M. Gooderham, B.A.Sc., M.E., who since his graduation at Toronto University in 1926 in electrical engineering, has been closely associated with welding. On leaving the university he joined the Lincoln Electric Co. of Canada Ltd., and later organized and developed the British and European business of the Lincoln group. In the early part of World War II, he became welding advisor to the British Ministry of Supply and promoted and assisted in the formation of the advisory welding service of that Ministry, and later became welding advisor to the shipbuilding branch of the Canadian Department of Munitions and Supply. In recent years he has been in private practice.

Another prominent Canadian Welding engineer to join the staff of the Bureau is W. Ralph Stickney, B.A.Sc., M.E.I.C., winner of the Duggan Medal and Prize for his paper on welding to the Engineering Institute of Canada in 1943. He is a graduate engineer from Toronto University in 1936. Most of his career has been devoted to welding and he has gained a broad experience by serving with the Canadian Bridge Co. Ltd., Walkerville, where he became Welding Engineer in 1939, and more recently at Canadian Vickers Ltd., where his duties embraced a very wide field of welding applications. In addition to the permanent staff of the Bureau, there will be a Welding Bureau Board, which has recently been formed. It will direct and control the operations of the Bureau and provide through its membership a liaison with both industry and the Canadian Standards Association. Members of the Board, all of whom are prominent engineers, directors or executives are:

Colonel A. H. Cowie, M.E.I.C.; Mr. E. S. Sargeant; Mr. D. S. Lloyd, M.E.I.C.; Mr. G. P. Wilbur, M.E.I.C.; Colonel W. R. McCaffrey, M.E.I.C.; Mr. M. N. Vuchnich.

Headquarters of the Canadian Welding Bureau are at present located at 86 Bloor Street West, Toronto; that of the Canadian Standards Association in the National Research Building, Ottawa.

* Taken from *the Engineering Journal*, March 1947.

NEW NONSYNCHRONOUS RESISTANCE WELDING CONTROL

A complete line of nonsynchronous packaged a.-c. resistance welding controls, known as Weld-O-Timer, is now available from Westinghouse Electric Corp., Buffalo. These new controls represent a departure from past practice in that it is possible to effect hundreds of combinations for sequencing and timing from only four factory wired subassemblies and two supplementary subassemblies.

Fig. 1—Weld-O-Timer in 600 and 1200 Frame Sizes with Access Door to Control Panel Closed

Made in two frame sizes, the 1200 and the 600, these new Weld-O-Timers are delivered in a unified, factory assembled package. They can be side-mounted to the welder; or, they can be floor mounted next to the welder; or, they can be mounted at any convenient place away from the welder with adjustment controls at the welder. But regardless of how installed, the replacement of a subassembly is a simple matter; loosen two nuts, disconnect the plug connectors, lift out.

The convenient finger tip control speeds production as each job can be quickly set. Voltage regulator tubes are incorporated in timing circuits to give more accurate timing when connected to welder supply circuits. A transparent access door in the 1200 frame size and a metal access door in the 600 frame size protects the control setting against unauthorized tampering. Inspection of subassemblies is simplified in both models through a front access door and in the 1200 frame size a swing-out feature provides access to rear of panel while in the 600 frame size this is accomplished by tilting the subunit panel forward.

Maintenance is reduced by ready accessibility to all parts, by factory assembled subunits, and simplified circuits which mean fewer parts.

Further information on these welders may be obtained from Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

AMPCO DISTRIBUTES PROCEDURE SHEETS FOR WELDING DIES

Two new procedure sheets discussing the welding of dies are being distributed by Ampco Metal, Inc., Milwaukee 4, Wis. The first of these describes correct methods of arc welding composite dies while the second covers aluminum bronze die repairs.

These sheets list recommended electrodes, correct polarity and currents, amperage and voltage, necessary preparation and other pertinent information.

Copies will be sent to interested welders on request.

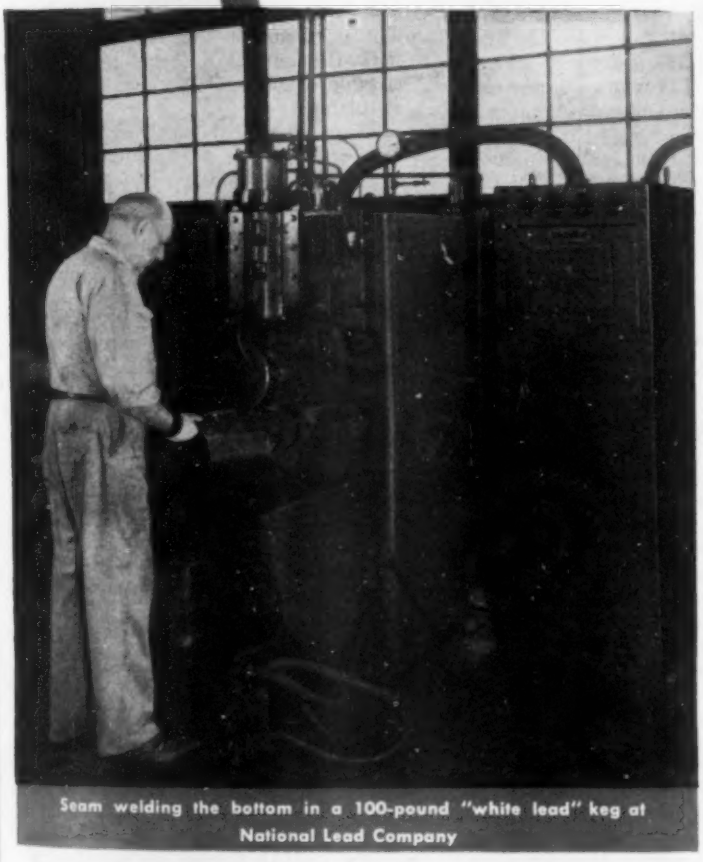
ACP-MO ELECTRODES

For welding low-alloy cast steel or low-alloy high-tensile strength rolled steels in all positions, with alternating-current or direct-current reverse polarity, the new ACP-MO electrode, available in four diameters from $^{3}/_{32}$ to $^{3}/_{16}$-in., is announced by the Westinghouse Electric Corp.

Although designed primarily for use with alternating-current, this electrode is exceptionally good when used with direct current, reverse polarity. ACP-MO should be used for vertical or overhead welding although it produces equally satisfactory results in making horizontal fillet and flat position welds. Welds made with this electrode meet the requirements of A.W.S.-A.S.T.M. tentative specifications for Iron and Steel Arc Welding Electrodes classification E-7011.

Kegs and Cans for Paint and Ammo.

GENERAL ELECTRIC WELDING CONTROLS Have Given National Lead *Better Quality in Less Time . . . Little Maintenance*



Seam welding the bottom in a 100-pound "white lead" keg at National Lead Company

Says Mr. Gerst, Plant Superintendent of the Steel Packaging Works of the National Lead Company: ***"We are well pleased with the General Electric controls. They have done a fine job.*** During the war, these controls were in continuous operation 16 hours per day, 6 days per week. Since we first installed them, they have required very little maintenance."

G-E synchronous precision controls helped increase National Lead's war production of 75 mm ammunition containers for the Government, and now, they are assuring a better quality of weld, reduced costs, and increased production of 100-pound kegs for packaging white lead in oil.

In addition to improved work quality and reduced production time and cost, this control has increased the life of the electrodes and reduced installation space.

A NEW, IMPROVED Line of Synchronous Precision Control

• Now, General Electric is featuring a new line of synchronous control which offers:

1. Savings in installation time—all controls are factory-wired, and included in one cabinet.

2. Easy installation—control cabinet is designed for side mounting on welding machine, within easy reach of operator.

3. Convenient servicing—cabled wiring and rack-mounted resistors provide easy access.

For further details, ask your local G-E office for bulletin GEA-4699.

HAVE YOU SEEN—

"This Is Resistance Welding," G.E.'s 30-minute, full-color movie? Your local utility or G-E office will be glad to arrange a free showing for you. Apparatus Department, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

Further information on the ACP-MO electrode may be secured from P.O. Box 868, Westinghouse Electric Corp., Pittsburgh 30, Pa.

NATIONAL RESEARCH COUNCIL*

On March 3rd, the Annual Meeting of the Division was held with a morning session of members and invited guests at which reviews of active projects were presented by the chairman or the head of the technical staff of the respective boards or committees.

There follows an excerpt from the report on welding research.

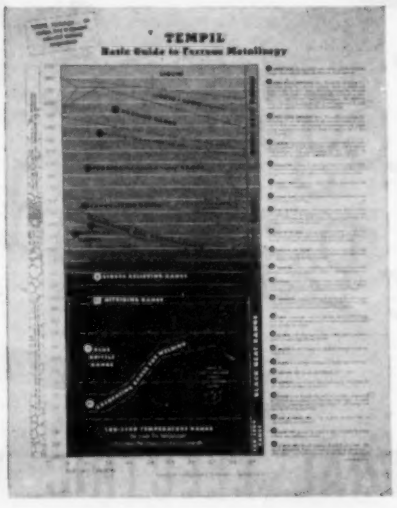
Committee on Ship Construction

On February 24th was issued the 164–page "Final Report of a Board of Investigation to Inquire into the Design and Methods of Construction of Welded Steel Merchant Vessels." This Board was a temporary wartime board established by the Navy. Throughout the major part of the Board's existence, the War Metallurgy Committee of the Division of Engineering, NRC, had a considerable part in the Board's research program. The present Committee on Ship Construction, is an outgrowth of part of the War Metallurgy Committee serving in an advisory capacity to the Ship Structure Committee, the peacetime successor of the temporary wartime Navy Board. In this relation, the Council's Committee on Ship Construction has assisted significantly in the compilation of this report. The report presents a historical study of ship hull fractures; discussion of the designs, materials, construction and operating conditions involved; outlines of specific investigations; a review of international exchange of information pertinent to the field; and the Board's findings and conclusions.

CHART OF FERROUS METALLURGY

A unique "Basic Guide to Ferrous Metallurgy," printed in 19 colors has been issued by Tempil° Corp. In its compilation, Tempil° have assembled the best available information from many sources and presented it in this schematic form. This chart will prove an invaluable aid in heat-treating, processing, welding and general fabrication of steels up to 0.9% carbon.

The chart shows the working characteristics of steels at temperatures from −300° F. to 2900° F. All the important temperature zones, including hot-working, annealing, normalizing, stress relieving, carburizing and preheating for welding are clearly defined. Temperature ranges are shown in 19 colors approximating the characteristic hot-body radiant hues. At the right of the chart 23 fundamental metallurgical terms are defined and explained. A diagram symbolizing the change in grain size with temperature is shown below.



This handsome plastic-laminated wall chart measures 16¼ in. wide by 21 in. long. It can be cleaned easily and will last a lifetime. It provides a handy reference source for the engineer, metallurgist and skilled worker.

Th chart is available gratis to industrial executives who request it on company stationery, stating their position. Address the Tempil° Corp., 132 West 22nd St., New York 11, N. Y.

DEAN C. E. MacQUIGG BECOMES CONSULTANT OF TAYLOR-WHARTON IRON & STEEL CO.

Dr. C. E. MacQuigg, Dean of Engineering at the Ohio State University, has been appointed a member of the consulting staff of the Taylor-Wharton Iron and Steel Co. of Easton, Pa. Upon being graduated in 1909, as Engineer of Mines from Ohio State University, he entered into the employ of the Santa Fe Railway on location and construction of a line in West Texas. In 1910, he became Assistant Engineer of Tests for the Anaconda Copper Mining Co., Great Falls, Montana. He left there in 1912, upon appointment as head of the department of metallurgy of the Pennsylvania State College where he did consulting work in the refractory and steel industries. In 1917, he was appointed captain in the Army Ordnance Corps in which capacity he engaged in metallurgical research and development. After his honorable discharge in 1919, he continued in this capacity as manager of the Research Laboratories of the Union Carbide and Carbon Corp. in New York. While with this concern he engaged in important study and testing of cylinders used in the transportation of gases under pressure. At this time, he also served as chairman of the T & S Committee of C.G.M.A. Morehead Medal, International Acetylene. In 1937, Dr. MacQuigg was appointed Dean of Engineering at the Ohio State University and director of the Engineering Experiment Station. In World War II he was commissioned as Lieutenant Colonel (inactive) in the Ordnance Reserve where he handled numerous assignments in N.D.R.C., E.S.M.W.T. and other projects. He is the present chairman of the Ohio Water Resources Board, a member of A.I.M.M.E., A.S.M.E., A.S.M. and holds the honorary degree of Doctor of Engineering.

INTERNATIONAL ACETYLENE ASSOCIATION TO MEET IN CINCINNATI MAY 20 and 21, 1947

Industrial and chemical applications of acetylene will be discussed at the Annual Convention of the International Acetylene Association to be held May 20 and 21 at Cincinnati. Latest developments in applications of the oxyacetylene processes will be described by well-known engineers and technical experts in the industry. A prominent member of the staff of a large chemical company will discuss the chemical uses of acetylene.

The Convention will open Tuesday noon with a luncheon at the Hotel Gibson, followed by a session of technical papers. The program for the day will conclude with the annual business meeting and election of officers. No evening sesssions are planned.

The sessions on Wednesday will be held at the University of Cincinnati. A program is being prepared which will be of interest to the students and faculty of the University, as well as to industrial users of acetylene and its allied products. The morning sessions will include several technical papers and a sound-color motion picture showing recent applications of oxyacetylene cutting. A feature of the Wednesday afternoon session will be the talk on the chemical uses of acetylene. Other talks are scheduled for this session concerning the applications of the oxyacetylene processes and also the opportunities in the welding-engineering field.

All sessions of the convention except the business meeting will be open to the general public, and there will be no registration fee. Details of the program will be announced later.

ELECTRODE FOR CAST IRON

The Wilson No. 575 all position electrode with a high nickel core wire and a heavy extruded coating has a possible application wherever an electrode is used on cast iron. This electrode will be of special use in the automotive field for work on all castings requiring machinable welds and for production line repair work. Ordinarily preheating is not necessary.

Because of its high nickel content, welds when properly made will be machinable, free from cracks and porosity and will exhibit adequate tensile strength and ductility for cast-iron welding. It can be used with ease in the downhand, vertical or overhead positions, and multiple pass welds can be made with virtually no danger of cracking.

The Wilson No. 575 electrode is immediately available in 5/32, 1/8 and 3/16 in. diameters and may be used on either a. c. or d. c.

Further information can be obtained by writing to Wilson Welder & Metals Co., Inc., 60 E. 42nd Street, New York 17, N. Y.

* Except from Report to Executive Board, N.R.C. from the Chairman Division of Engineering and Industrial Research.